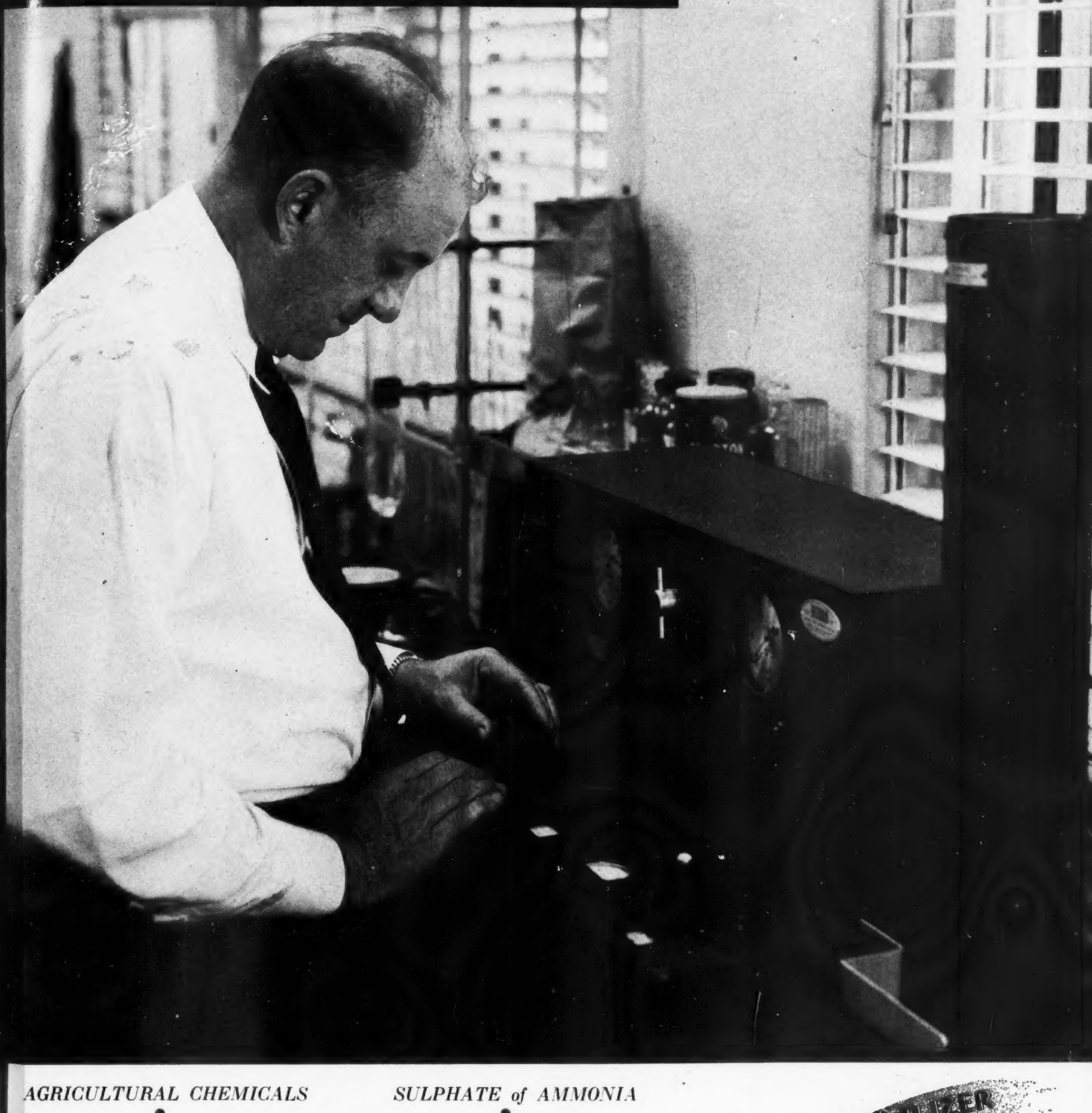
ERICAN FERTILIZER & ALLIED CHEMICALS



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AMERICAN FERTILIZER & ALLIED CHEMICALS

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Vol. 114 JANUARY, 1951 No. 1

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Cover

Large commercial canning companies are highly interested in the quality of the food that they purchase and work closely with farmers who contract their crops in advance. On the cover, Dr. Jackson B. Hester, chief soils technologist for the Campbell Soup Company, is using a Beckman Flame Spectrophotometer of modern design to determine the amount of mineral in crops purchased by his company. Tests help in making fertilizer suggestions to growers for the coming year.

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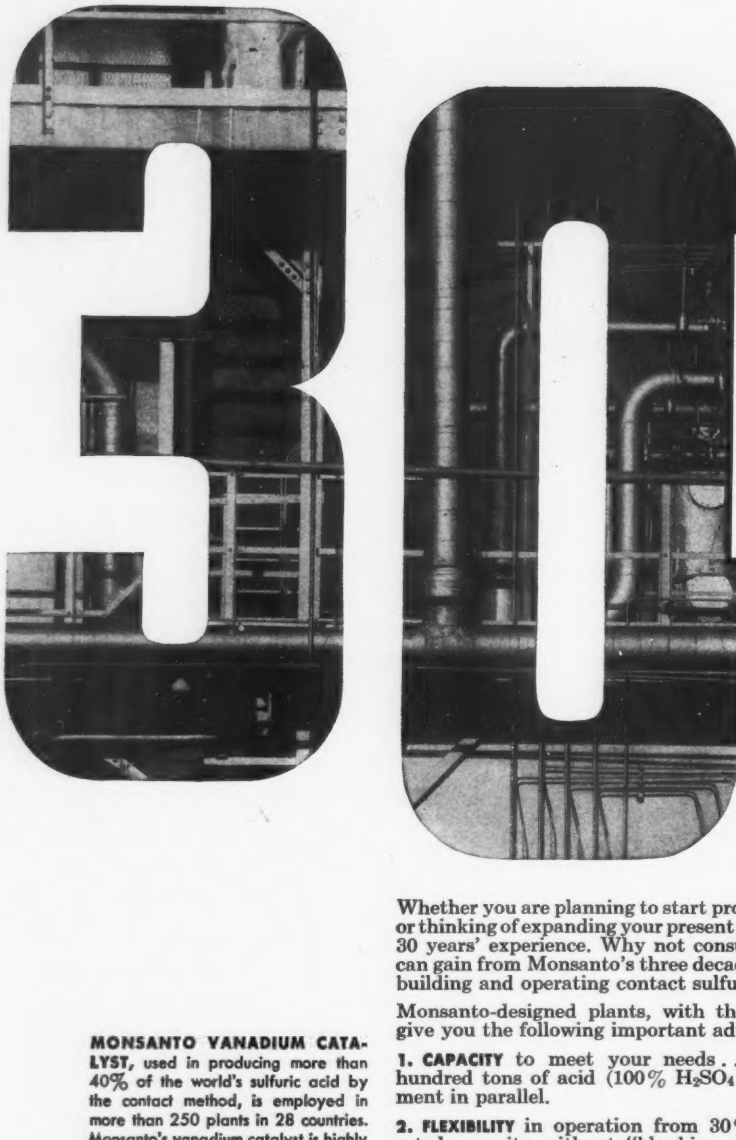

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SERVING INDUSTRY . . . WHICH SERVES MANKIND

A Look at 51

It's going to be a busy year for the American fertilizer and allied chemicals industry. No matter what happens, the industry will have to produce more and better products than ever before. To do so, it will have to exert all its skill in management, invention, and production if it is to stay in the contest.

One fact we are just beginning to face is that this war is different. In previous wars we have been able to wait until the last minute, then drop everything and go put out the fire. The "all-out" efforts were made with the idea that they were temporary in the strictest sense of the word. This time, we must be ready to turn a fully-prepared military establishment into the field at a moment's notice while at the same time recognizing that this state of bated-alert might drag on for a generation. For that reason, the peacetime economy of the nation must be kept in a healthy growing condition.

One sign that Washington recognizes this two-pronged need is its attitude on education. Good students will be deferred until they get their degrees, some of the most promising students—especially in the technical sciences—will be allowed to continue studying in order to earn advanced degrees. This is not a form of intellectual snobbery, but a healthy respect for the importance of properly trained scientists and technicians. There is also a great need for advanced *general* education and many apt students might well be deferred for this purpose; but that is hard to sell the public because the practical results are harder to see. The point is, the administration recognizes the necessity for trying to do two things at once that America has always done one at a time in the past.

Industry, to answer this double-barreled challenge of simultaneous War-*and*-Peace, will have to add a full-scale production-for-war on top of its already full-blooming production-for-peace. To do so, industry is expanding its plant facilities to the largest ever. International Minerals and Chemical Corporation, for example, last month began construction of a modern, 40,000-ton superphosphate plant at Fort Worth. The plant is expected to be in operation by June. Other firms are following suit, or already have plants under construction.

Until the expansion program is completed and until the demands of the military are fulfilled, farm chemicals manufacturers must operate in the face of wartime shortages. The lack of sufficient sulfur has already created a dirth in the supply of sulfuric acid, with no immediate relief in sight. Its use for the assidulation of phosphate rock may give way during 1951 to other methods now developed well beyond the pilot-plant stage. Chlorine and benzene, basic materials for many pesticides (DDT, for example) are in short supply for agricultural uses. Although plant capacity is up, the chemicals have many military uses and these must be met first.

Packaging and transportation may become bottlenecks in the first half of 1951. Increased plant construction to bring producers geographically closer to consumers may ease the strain on packages and heavy transport alike. By shipping dry materials in bulk, short hauls may be made by truck without packaging. And no gasoline or tire shortages are in sight now. Of course, inflammable and toxic materials, as well as liquids, would still require containers of one kind or another.

Biggest headaches during the first half of '51 are likely to be in a few vital war materials—of which there simply will not be enough to go around—and in manpower. Accelerated research will be needed to develop substitutes; and allocations, if they come, will certainly take cognizance of the vital need for farm chemicals. No matter what the strictly-military demands of the nation may be, land must be kept at a high level of productivity and crops must be protected from pests, disease, and spoilage during growth and harvest. Manpower shortages, both in the factory and on the farm, will be met partly by increased use of machinery, partly by increased employment of women in all lines of work.

With luck, the war—for which we must be ready within the next few months—won't come this year. If not, the probability of war at all will be smaller than at any time since the cold war began. This, added to the phenomenal growth and activity of our industry in recent years, will make its future look brighter than at any time during the last 21 years.

The job will call for hard work and ingenuity and the tangible rewards won't always be great. As profits rise, taxes (at all levels of income) will soar. In some cases, the government may take more than sixty cents out of every profit dollar. High as the price may seem, it will be preferable to the ballooning inflation that would follow if some kind of pay-as-we-go policy were not followed.

That is why, at the beginning of this attempt at soothsaying, we said that 1951 will be a busy year. Perhaps the busiest ever.

—A. M. Brodine

Here is a review of recent work done at the New Jersey Agricultural Experiment Station by soil scientists Chester D. Leonard and Firman E. Bear. Use of radioactive sodium as a tracer was partially responsible for the conclusion that, for specific crops, sodium has distinct agricultural value

Sodium

as a fertilizer

Tests involving the use of a radioactive tracer show that many plants produce higher yields with sodium as a fertilizer than without it. Sodium, the earth's fifth most abundant mineral element, improves plant vigor, disease resistance, flavor, color of foliage, and the keeping quality of a number of crops. These are some of the facts about sodium reported by soil research scientists Firman E. Bear and Chester D. Leonard at the New Jersey College of Agriculture, Rutgers University in a recent bulletin.

For all its abundance, however, sodium always occurs in nature in combined form (as in common salt, Chilean nitrate, borax, albite, and diorite.) Although New Jersey soils were found to contain between 10,000 and 20,000 pounds of the element to the acre at plow depth, the soils in that state have little sodium in forms available to plants.

Soil does not hold sodium as strongly as it does potassium and as a result the amount of "exchangeable" sodium in high-rainfall areas is fairly small. (Exchangeable sodium is that which is adsorbed on the surfaces of the finer soil particles. It is considered to be available to plants.) Soils of different types, including virgin Dover loam, Sassafras sandy loam, and Penn silt loam, were analyzed for their exchangeable sodium and potassium content by Leonard and Bear. Dover loam had 46-pounds sodium in the plowed acre, and 140-pounds potassium. Sassafras sandy contained 100-pounds sodium per acre, 140-pounds potassium. Penn silt loam soils had only 78-pounds sodium as against 312-pounds potassium.

Some plants take up large amounts of sodium when it is available to them. Plants of this type may contain more than 200 times as much as plants that do not readily accumulate it. Plants that have a high sodium content when grown in soil containing considerable amounts of the element in available form generally show increased yields when fertilized with sodium, but those that contain very little or no sodium may not. Plants in which the ratio of potassium to sodium is low when both elements are available usually show increased yields following the use of sodium as a fertilizer. These are given as general rules only; the scientists doing the work say there are some exceptions. *(Continued on next page)*

Leaves from celery plants fed with radioactive sodium took picture of themselves when pressed against a piece of X-ray film in darkened room

Light areas indicate radioactive sodium taken up by plant. Radioisotopes used in this test were produced, not in an atomic pile, but in the cyclotron

Chemically, sodium is very similar to potassium and it apparently is able to perform some of the functions of potassium in those plants that show increased yields following application of sodium to the soil. The amount of yield-increase from sodium fertilization is usually greater with a limited than with an abundant supply of potassium in the soil.

Greenhouse Experiments

To test this apparent ability of sodium to substitute for part of the potassium generally required by plants, greenhouse experiments were conducted to determine the importance of sodium to red table beets. Nine nutrient solutions, with three levels of potassium, and, with three levels of sodium at each potassium level, were used on plants grown from seed in 1½-gallon earthenware pots filled with well-washed quartz sand which served merely as a mechanical support for the test plants. Except for variations in potassium, each solution contained a balanced supply of all known essential plant nutrients. After 2½-months the plants were harvested and analyzed.

It was found that the best growth was obtained with the high-potassium level, and that addition of sodium at that level produced no increase in yield. The medium-potassium level was insufficient for best growth, but addition of sodium resulted in marked increases in yield of both roots and tops. Addition of a medium amount of sodium at this potassium level nearly doubled the yield, and addition of more sodium gave an even larger increase.

In the low-potassium, no-sodium test, the beets were very small. Addition of sodium produced marked increases in yield of both tops and roots at this level of potassium, but growth was still not satisfactory. Obviously, more potassium was needed for normal growth than was supplied in this treatment. This indicates that sodium performs only part of the functions of potassium in the nutrition of beets.

At all three levels of potassium, the sodium content of both tops and roots increased consistently with each increase in sodium in the nutrient solution. At any given level of sodium, its content in the beets increased as the potassium content of the nutrient solution was reduced. Likewise, the potassium content of the beets decreased with increases of sodium in the nutrient solution. This indicates a replacement of potassium by sodium.

Different Tests With Celery

Experiments with celery and other crops were run on a slightly different basis, but celery yields increased as the potassium was reduced from 195 to 39 ppm and replaced by equivalent amounts of sodium. These increased yields were maintained when the potassium was further reduced to 8 ppm and replaced by equivalent amounts of sodium. Similarly, the sodium content of the celery rose rapidly as that of the potassium decreased.

Analysis of harvested plants showed that the plants took up a fairly constant sum of sodium-plus-calcium-plus-magnesium, in spite of the large variations in their content of sodium and potassium. Thus, with celery, sodium not only replaced potassium in about the same amounts but it apparently performed most of the functions of potassium and it increased the yield over that produced by potassium alone. "In other words," say the scientists making the study, "it has been demonstrated that sodium has considerable agricultural value for this crop."

Sodium On Other Crops

Sodium as a nutrient for radishes, lettuce, oats, and tomatoes was studied in the same way as that used for celery. Radishes, lettuce, and oats showed no reduction in the dry weight of the tops when the potassium in the nutrient solution was reduced from 195 ppm to 39 and replaced by equivalent amounts of sodium, but the tomato plants showed some decrease in yield, notably of the fruit. The yields of all four crops were lowered by one-half when the potassium was reduced in this way and replaced by sodium. And when the potassium was further reduced to 8 ppm the yield dropped to about one-eighth.

In oat plants, the sodium content was about the same as that of the celery, but that of lettuce was a little lower. Radish tops were a little higher in sodium than those of celery and oats, and the radish roots contained considerably more sodium than the tops. Both leaves and stems of tomatoes contained much less sodium than the other three crops.

To study the distribution of sodium in the plants under investigation, Dr. Bear and Dr. Leonard turned to one of science's newest tools, a by-product of the Atomic Age, the radioactive isotope of sodium—a so-called "tagged" or "tracer" element. Like other radioactive elements, radioactive sodium is unstable. That is, it won't stay in its radioactive form forever, but will gradually disintegrate and in the process it gives off radiations that can be counted.

Radioactive sodium in solution can be fed to plants and will be absorbed by them like normal sodium. The presence of very small concentrations of radioactive sodium in any plant part can be detected by a Geiger counter and the amount of chemical present can be determined from the number of counts per minute recorded by the detection device. For example, one microcurie of radioactive sodium will give off 2,200,000 radiations a minute.

Also, the radiations emitted by radioactive sodium will darken an X-ray film so that a type of photographic picture called a radioautograph can be made of a plant part containing the radioactive isotope by exposing the film to the part in the dark. When a print is made from the film those parts of the plant having radioactive sodium in them will appear light and seem to glow. Thus, the accompanying pictures of a celery leaf were made by the radiations from within the leaf and no external light of any kind was used to take the picture. The exposure, made in a completely dark room, took 12 days.

How It Was Done

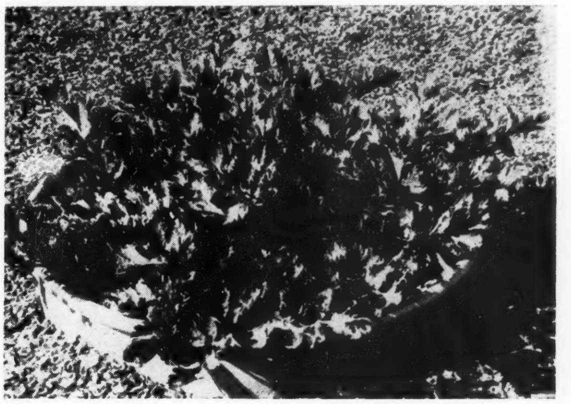
Tomato plants were grown in sand cultures at three levels of potassium and sodium until they were 4-feet high and bearing small green fruit. Then they were treated with radioactive sodium applied to the surface of the soil and supplied with the same type of nutrient solution that had been fed to the plants previously. Additional nutrient solution was added as needed to take care of the normal water and nutritional requirements of the plants.

The growing tips of individual plants were collected at various intervals ranging from ¼-hour to 94 hours after the radioisotope had been applied. At the same time, the first mature compound leaf below the growing tip, normally about 6-inches away, was collected and separated into its component leaflets and petioles.

No movement of radioactive sodium into the petioles of the first mature leaf was noted until the first ½-hour sampling period. Translocation of radioactive sodium from the petioles to the blades of the leflets in detectable amounts did not occur with the high-potassium and no-sodium treatment until sometime between the 3-and 18-hour sampling periods. With the low-potassium and high-sodium treatment,

Without sodium. Celery yield one week before harvest of plant fertilized with potassium chloride to which N was given in ammonium nitrate form

With sodium. Celery yield one week before harvest. Plants were fed same plant food as control plots, N given in the form of sodium nitrate



however, the presence of radioactive sodium in the leaflets was noted after 1 hour. The concentration of radioactive sodium in the leaflets, petioles, and growing tips of the plants grown at the high-potassium and no-sodium levels increased until 90 hours after the application of the radioisotope. At the 94-hour sampling period, marked decreases in radioactive sodium were noted in all plant parts tested. In the low-potassium and high-sodium treatment, the concentration of radioactive sodium decreased after 66 hours. In every case, the concentration of radioactive sodium was higher in plants receiving the low-potassium and high-sodium treatment than in those receiving the high-potassium or low-sodium treatment. This indicates that potassium depresses sodium uptake by plants.

Conclusions From Field Tests

Similar tests conducted with celery and tomato plants, dead leaves on both green and white celery stems, and comparisons between the relative activity of the radioisotope taken up by them, and field experiments to further test the influence of sodium on yield and composition of a variety of crops, led the scientists to a number of conclusions as to the fertilizer value of sodium. Among other things, the tests indicate that on soils that are low in available potassium, the use of sodium fertilizers may be advantageous for sugar beets, Swiss chard, celery, and spinach, and possibly for tomatoes. No sodium was found in the stalks, husks, cobs, or grain of sweet corn under any treatment used, and only an extremely small amount was found in the leaves. Pepper plants, similarly, did not take up significant amounts of sodium.

In many soils of the semi-arid regions of the Western United States, topography, climate, and irrigation have all contributed to what is now a serious salinity problem. The soils of those areas usually contain much more sodium than those of humid regions because the rainfall is less, and there is less loss by leaching in the more arid regions. But more serious than the high salt content, which can be corrected by leaching and drainage, is the problem presented by the so-called "black alkali" in the soils that are relatively high in exchangeable sodium. Soils so affected tend to become impermeable to water and air, difficult to work, and poor media for growing plants. To determine what effect the continued use of sodium fertilizers would have on New Jersey soils, a leaching experiment was carried out by the Rutgers scientists.

Nearly neutral Dover loam, acid Sassafras sandy loam, and acid Penn silt loam soils were placed in waterproofed cardboard tubes having perforated metal bottoms. Ten inches of topsoil was used in each case, with 10 inches of subsoil for the Dover loam, and 15 inches for each of the other two. To prevent drying out and bad physical effects, the soil was covered with 2 inches of glass wool. The experiments showed that sodium fertilizers equivalent to 20 yearly applications of 200-pounds K_2O an acre did not increase the amount of exchangeable sodium in the soil enough to damage its physical condition. The rate of movement of water through the soil slowed down after the equivalent of 15 years' treatment, but this slowing down was no more pronounced with sodium than with potassium or ammonium fertilizers.

Reports From Other Areas

The Rutgers scientists report that experiment stations of other states have observed increased yields from use of sodium fertilizers on asparagus, barley, broccoli, Brussels sprouts, cabbage, carrots, celeric, cotton, flax, kale, Kencucky bluegrass, kohlrabi, mangels, millet, oats, peas, radishes, rape, rutabagas, sweet potatoes, turnips, and wheat. Celery, mangels, sugar beets, Swiss chard, table beets, and turnips showed increased yields with sodium fertilization even when the amount of available potassium was adequate. Buckwheat, corn, cucumbers, lettuce, onion, parsley, parsnip, peppermint, potato, rye, soybean, strawberry, sunflower, and white bean showed little or no yield increase from sodium regardless of the potassium supply. Many other crops have not been tested, and the classification given here is only tentative. Under different experimental conditions, say the soil scientists, other results might be obtained.

Farmers on muck soils in Michigan use sodium very extensively as a fertilizer on celery, table beets, and sugar beets. Most of the large growers of table beets for canning in the Geneva, New York, area use sodium regularly as a fertilizer. The sodium not only increases the yield but improves the quality and flavor of the beets. The color and flavor of the tops are also improved, a matter of interest to people who use them for greens. On mineral soils at the Geneva Experiment Station, sodium increased yields of table beets even when 200 pounds of K_2O an acre was provided.

How Sodium is Applied

Sodium is widely applied to the soil in the form of nitrate of soda, which contains 23 pounds of sodium for every 14 pounds of nitrogen added. It is also applied in the form of common salt. Tests at the Geneva Experiment Station showed that the yield of table beets was virtually the same no matter whether the sodium fertilizer was applied broadcast before plowing, broadcast after plowing and just before seeding, or as a side-dressing after the beets were up. In general, it appears desirable to broadcast sodium fertilizers after plowing for close-drilled crops and to apply them as a side-dressing for row crops. Sodium chloride tends to take up moisture and if mixed with other fertilizers may cause caking, unless drilled shortly afterward. In Michigan, a mixture of dry rock salt with other fertilizers kept in good physical condition for a year after it was made up.

According to Bear and Leonard, writing in the bulletin from which this summary was taken, farmers might well give consideration to the use of sodium fertilizers not only for the specific crops reported on, but for a number of others that have been found to give increased yields with sodium. ◆

Two New Chemicals

that show high promise for more effective defoliation and selective weed-control

The material in this article was presented at the Northeastern Weed control Conference in New York City, January 3–5, in two papers: "Killing of Leaves and Defoliation of Plants by Chemical Means," by P. W. Zimmerman, A. E. Hitchcock, and Henry Kirkpatrick, Jr., of the Boyce-Thompson Institute for Plant Research, Yonkers, N. Y., and "Chemical Weed Control in Corn, Cabbage, Tomato, and Other Crop Plants," by the same authors.

CHEMICAL weeding although having a good future, has not proved entirely satisfactory and there are definite needs for better methods and better chemicals for killing leaves and defoliating plants. Both these problems recently yielded some ground to two acids that may have wide application as new farm chemicals. Technically named Monochloroacetic acid and Undecylenic acid, the two chemicals have not previously been considered as herbicides.

In the past, some success in the chemical weeding of row crops has resulted from the use of controlled directional spraying, with or without the use of shielding equipment. In such work the edge of the spray is directed toward the bases of the plants under conditions which do not permit a toxic dose of the herbicide to contact the foliage of the upper, most sensitive part of the plants. At certain stages of growth such crops as corn, snap beans, onion, carrots, and cabbage, can be weeded between the rows and partially or completely weeded in the row by proper directional spraying with herbicides which have little or no residual effect on the crop. This has not worked out too well in practice, however, either because the period of weed control is not long enough or because of adverse effects of the herbicides on crop plants. There is still a need for more effective herbicides for controlling grasses and broad-leaved weeds without causing injury to crop plants.

Defoliation is, like weed, control, an important problem in agriculture that could profit from the development of improved chemical methods. Roses and other nursery stock need to be defoliated before they are placed in storage. It would be helpful if leaves of holly and many other species could be chemically defoliated before being transplanted. Threshing of soybeans could be facilitated if the leaves were killed or the plants defoliated before harvest. Increased yields and a better quality of cotton result from killing the leaves or defoliating the plants in the field.

As the principal herbicides in their weed control experiments, the Boyce-Thompson scientists used the two acids, singly and in combination. Monochloroacetic acid, whose chemical formula is ($CH_2C1COOH$), is water soluble, while undecylenic acid [$CH=CH(CH_2)_8COOH$], is only slightly soluble. In some cases the triethanolamine salts of the two chemicals were prepared and then used in water solutions. The water soluble polyethylene glycol ester of undecylenic acid was also used in some of the tests. Spray solutions of the herbicides were applied in most cases at a concentration of 1 per cent, using 0.25 per cent Nekal NS as a wetting agent. Over-all and between-row sprays were applied to most crops at various stages of growth with respect to weeds and the crop plants.

A Hudson Junior 2-gallon sprayer, fitted with one Spraying Systems Teejet No. 8015 nozzle, was used in applying the sprays. Rates of delivery, sufficient to wet the foliage thoroughly, varied with the size of the weeds from approximately 125 gal. per acre on the smaller weeds to 300 gal. per acre on the larger ones.

Test plots varied in size from 100 to 300 square feet. Crop plants included sweet corn, cabbage, potato, tomato, onion, carrot, and snap bean. The main weeds found in the plots were purslane, *Chenopodium* album, crabgrass, galinsoga, chickweed, smartweed, ragweed, mustard, *Amaranthus*, oxalis, and white clover. Sedges and barnyard grass were also sparsely

scattered throughout the plots.

In the greenhouse, a large number of compounds were tested at concentrations of 1 per cent and 3.2 per cent. Of the substances tried, many, particularly those effective at 1 per cent, killed one or more species of weeds, but monochloroacetic acid (ClA) and undecylenic acid (UN), were especially effective for killing young weed seedlings in from less than 1 hour to 24 hours without causing noticeable residual effects in the soil. These two herbicides exhibited a selective action against several species of pot-grown herbaceous and woody ornamental and crop plants. When gladioli and corn were 12 inches or higher, no injury resulted from treatment with a 1 per cent solution of ClA or UN when the sprays were applied to the lower 4 inches of the plants even though weed seedlings were completely eradicated. Other pot-grown plants that were weeded effectively by controlled directional spraying with a 1 per cent solution of ClA or UN included *Euonymus radicans* variety *vegeta*, *Ilex*, species of Orchid, peach, loblolly pine, *Taxus*, species of gardenia, carnation, and rose.

As both the acids under test are contact herbicides which exhibit no noticeable residual effect in the soil, their application as pre-emergence sprays was arranged so that a substantial number of weeds had germinated before emergence of the crop. Under these conditions ClA and UN killed the emerged weeds and, as judged by the lasting effect of the treatment, presumably many weed seeds that had germinated at or near the surface of the soil were also killed. Thus, the crop emerged through a practically weed-free soil surface that remained nearly weed-free for about 30 days after treatment. ClA, UN, and a mixture of equal parts of these two acids were equally effective at a total concentration of 1 per cent.

In one experiment in which the sprays were applied 3 days after planting, 1 per cent solutions and mixtures of the two were compared with their respective salts. All except the amine salt of UN killed most or all weeds and gave good weed control for at least 3 weeks. The amine salt of unde-

TABLE I

Herbicide	Formulation	Yield of pods (oz.) for each picking			Total Yield (oz.)
		First	Second	Third	
ClA	**Acid**	**67**	**62**	**74**	**203**
	Salt*	**41**	**42**	**71**	**154**
UN	**Acid**	**74**	**45**	**73**	**192**
	Salt*	**80**	**45**	**68**	**193**
ClA 0.5%	**Acid**	**65**	**32**	**70**	**167**
UN 0.5%	**Salt***	**69**	**30**	**51**	**150**
Control	...	**57**	**54**	**64**	**175**
	...	**61**	**34**	**65**	**160**

**Triethanolamine salt*

The table above shows the comparative yields of snap beans sprayed with ClA and UN, both separately and mixed in equal parts, 3 days after planting and 10 days after preparation of plots

The table below shows the percentage of leaf damage and leaf fall after woody plants had been sprayed with 1.0 per cent solutions of ClA and UN acids and with their triethanolamine salts

TABLE II

Species	ClA				UN			
	Leaf damage % total		Leaf fall, %		Leaf damage % total		Leaf fall, %	
	Acid	Salt	Acid	Salt	Acid	Salt	Acid	Salt
***Viburnum* sp.**	**50**	**75**	**100**	**0**	**20**	**0**	**0**	**0**
***Crataegus* sp.**	**95**	**0**	**100**	**0**	**95**	**50**	**100**	**95**
***Hibiscus* sp.**	**75**	**25**	**100**	**0**	**0**	**0**	**0**	**0**
American holly	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lilac	**50**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Spruce	**95**	**95**	**0**	**0**	**0**	**0**	**0**	**0**

cylenic acid killed only about 25 per cent of the weeds, but the remaining ones were injured and retarded in growth. The growth of bean plants and the yield of pods were the same in this plot as in the plot treated with the acid formulation of UN. The combined yields from the plots treated with the acid and its amine salts were significantly greater than the yields from the two control plots. These results are shown in Table I.

Predominant weeds in the bean plots included purslane, crabgrass, mustard, galinsoga and chickweed. Throughout the tests, there was a 70 to 75 per cent reduction in weed growth in the plots receiving the effective treatment. The fact that there was no reduction in yields of bean pods even on plots where only 25 to 75 per cent of the weeds were killed, indicates that complete eradication of weeds is not always necessary for effective weed control.

Spraying Times

Post-emergence sprays, including between-row sprays and overall sprays were applied to plots of sweet corn, potato, cabbage, tomato, onion and carrot. The overall sprays caused injury to the crop plants, the degree of injury varying with the species and the age of the plants. In the order of their decreasing susceptibility to the 1 per cent sprays, were: tomato, carrot, sweet corn, onion, potato, and cabbage. In general, younger crops were more severely injured than older plants just as in the case of weeds. For example, sweet corn up to about 12 inches in height was killed by a 1 per cent spray of undecylenic acid. Corn over 12 inches could be sprayed on the lower 4 inches of the stem with the same substance without injury. Monochloroacetic acid was less toxic to corn than the undecylenic acid.

Between-row sprays were very effective if the sprays were applied when the weeds were 4 inches or less in height. One per cent solutions of ClA or UN either alone or in mixtures, killed young weed seedlings with no adverse effect on the crop plants if, again, care was taken to direct the spray toward the base of the crops. If a few spray drops accidentally contacted the old leaves on crops such as cabbage, the resulting injury was local with apparently no translocation of the chemical beyond the place of contact. Mixtures of either ClA or UN with 2, 4-D proved very effective, especially on plots containing both grass and broad-leaved weeds.

In tests on sweet corn, 1 per cent sprays containing the triethanolamine sale of UN were relatively more effective in killing grasses than broad-leaved weeds such as *Chenopodium* album or purslane. In contrast, the UN acid emulsion sprays killed the broad-leaved weeds as well as the grasses. The ClA sprays also displayed selective action and were less effective on grasses than on broad-leaved species. There was little or no difference in the effectiveness of the acid and salt formulations of ClA as related to selectivity.

From testing the two compounds as weed-control chemicals, the scientists concluded that one per cent solutions of monochloracetic acid and undecylenic acid killed young weed seedlings without causing adverse residual effects on the crop when the herbicides were applied as pre-emergence and between-row post-emergence sprays. Both herbicides were selective, the degree of selectivity varying with the species of weeds and crop plants.

To test the two chemicals and their amine salts as defoliants, the sprays were applied to hybrid tea rose, apple, peach, string bean, viburnum, spruce, American holly, lilac, hawthron, hibiscus, garden bean and soybean. Sprays at 1 and 3.2 per cent concentrations of both chemicals were used as well as mixtures of equal amounts of the two. When the rose plants were sprayed with 1 per cent solutions of either chemical or mixtures of the two, 90 per cent of the leaves fell within 10 days. No injury to the buds resulted from an application of 1 per cent sprays. Regrowth during August and September occurred shortly after the plants were defoliated.

Both chemicals used at 3.2 per cent concentrations killed all the leaves within a week but interfered with leaf fall. Better leaf fall was obtained with lower concentrations. Also, young tips of the rose plants were either injured or killed when sprayed with 3.2 per cent solutions. Older or dormant axillary buds were not killed with the higher concentrations. Regrowth occurred within three weeks after the plants were sprayed with 3.2 per cent solutions. Older leaves fell more readily than younger leaves near the tip.

The amine salt of monochloroacetic acid was equally as effective as the acid itself. However, the amine salt of undecylenic acid was relatively ineffective compared to the acid. The mixtures of the acids were slightly more effective than either of the acids alone. When applied to plants for the purpose of defoliation, these substances also killed young weeds growing under the plants. Crabgrass, purslane, chickweed, and so forth were eradicated from the garden although they were not intentionally sprayed.

Apple and peach trees sprayed with 0.5 per cent ClA lost 95 per cent of their leaves without any visible injury to stems or buds. At a 1 per cent level ClA killed all the foliage on apples and peaches but not all of the dead leaves dropped. Some stem injury resulted from 1 per cent sprays applied to peach. UN sprays did not injure leaves of apple or peach, but neither did this chemical cause leaf fall. These results are summarized in Table II.

Selective Action

The lack of injury induced by 1 per cent sprays of UN in some of the species is of considerable interest as it shows selectivity. For example, spruce trees were entirely resistant to UN, which indicates that the chemical might be used for weeding nursery rows or protecting spruce from competing species. In all probability, other important species will show similar resistance.

Another finding, and one that will be of special interest to orchardists, is that apple branches sprayed in May when the tree was in flower indicated that the chemicals might be useful for thinning fruit. When in the pink flower bud stage, the fruit set was reduced

(*Continued on page 36*)

Parathion and DDT Residue Studies

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COMMERCIAL use of various formulations of DDT and parathion by lettuce growers in New York state made it necessary to conduct extensive residue studies pertaining to these materials. The studies were divided into two phases: (1) The determination of the amounts of insecticide on the crop at market time when the time of last application was varied from four days to more than a month prior to harvest; and (2) a study of factors such as growth and weathering that tend to reduce the amount of insecticide on the plants.

The insecticides are applied by the lettuce growers for the control of the six-spotted leafhopper, the known carrier of lettuce yellows. DDT and parathion are used as dust or wettable powder spray formulations and DDT applied as an emulsion-type spray. Normal commercial applications are begun as soon as the lettuce plants are above ground and stopped some 2 to 3 weeks prior to harvest; the dusts and sprays being applied at 5- to 7-day intervals. Earlier investigations by other workers had revealed that there was little danger of excessive DDT residue if the applications were stopped 3 to 4 weeks prior to harvest. However, because of the limited data and the possibility of harmful residue if the grower did continue his applications beyond the recommended time, investigations were started to further look into this problem.

Residue studies were made in conjunction with regular field plots used in six-spotted leafhopper control studies. The date of the last application was varied from 4 to 33 days prior to harvest. Five lettuce plants were taken for residue analysis after the last application and at harvest. The harvest sample was divided into 2 parts, the lower leaves, and the market heads. The lower leaves are normally left in the field by the grower. The market heads were considered to be representative of the lettuce as it is marketed commercially. The results reported here were obtained from 126 samples taken from plots in Oswego county, New York, over a period of 2 years.

In tests with DDT emulsion sprays applied 4 to 5 times at the rate of 0.75 pound of DDT per acre, the samples taken immediately after the last application showed deposits ranging from 9.1 to 192 ppm. The harvest samples, taken 18 to 33 days later, had residues of 0.1 to 5.6 ppm on the lower leaves and 0 to 0.9 on the market heads.

This article is a summary of two scientific papers reporting results of work extending over a two-year period by a team of Cornell entomologists including M. J. Sloan, W. A. Rawlins, Barbara Gast, L. B. Norton and presented at the Eastern Branch meeting of the American Association of Economic Entomologists in Philadelphia, November 20-21, 1950. The papers will appear soon in the "Journal of Entomology."

DDT wettable powder sprays were applied using 1 pound of DDT per acre per application. Four and 5 applications produced residues of 9 to 572 ppm on lettuce plants analyzed after the last application of DDT. At harvest time, 11 to 25 days after the final application, the lower leaves analyzed 0.4 to 38 ppm but only nominal amounts of 0 to 0.4 ppm were found on the market heads. The danger of later applications became apparent when a sixth application was made 4 to 6 days before harvest. Here the residue on the market heads ranged from 1.9 to 5.4 ppm.

The number of DDT dust applications varied from 3 to 5 and the date of harvest 16 to 24 days after the last application. The range of deposits found when the insecticide was applied at the rate of 0.2 pound of DDT for 1 application per acre were as follows: After

A timely report on the relative importance of growth and weathering in the reduction of poisonous residues on commercially grown lettuce crops as well as the actual amounts of insecticide present at marketing time

the last application—6.1 to 62 ppm; harvest sample, lower leaves—0.6 to 2.2 ppm; and market heads—0 to 0.5 ppm.

Parathion was applied 4 to 6 times as a wettable powder spray at concentrations of 0.075 pound of parathion per acre. Residues found on lettuce samples immediately after the fourth or fifth application varied from 0.5 to 2.9 ppm. Harvest samples, taken 4 to 24 days after the final application, showed 0 to 0.4 ppm on the lower leaves and 0 to 0.1 ppm on the market heads.

A dust formulation of parathion was applied 3 to 5 times using 0.4 pound of parathion per acre in each application. Samples taken from lettuce fields after the final application had residues of 2.1 to 13.2 ppm. Sixteen to 24 days later, the harvest samples were taken. The lower leaves were found to have 0 to 0.1 ppm and the marketable heads 0 to 0.2 ppm.

In all harvest samples analyzed it was found that the greatest part of the residue was on the lower leaves; this being the portion of the plant that, in commercial practice, is left in the field at the time the lettuce is cut for market. An average of all harvest samples for the 2 seasons showed the lower leaves represented 32 per cent of the total weight of the lettuce plant at the time of harvest.

The fact has long been recognized that growth, alone, is a very important factor in the apparent reduction of insecticide residue. Even though this reduction is due only to an increase in weight of the plant, and not an actual loss of insecticide.

When the residue determination is made on the basis of parts per million, or one part of insecticide deposit per million parts of plant, it is obvious that the initial deposit of insecticide on a fast growing plant would reach low levels much more rapidly than on a slow growing plant. Also it is clear that the many phenomena, sunshine, wind, rain, volatility and others, that are grouped under the general heading of "weathering" play an important part in the decomposition and loss of actual insecticide deposit.

To date little attempt has been made to evaluate the effect of growth quantitatively or to show the relative importance of both growth and weathering on the apparent reduction of residue on a fast growing crop such as lettuce. The residue work during the summers of 1949 and 1950 was planned to cover some of these problems as well as to give the usual information on final harvest residue.

Plants for this study were obtained from plots that were treated with various insecticides for six-spotted leafhopper control experiments. The same plots, and many of the same residue samples as were used in the determinations reported above were employed.

To determine the magnitude of growth it was necessary to plot a growth curve. To plot a growth curve the weight of lettuce was taken at various intervals from the time of the last application of insecticide until the date of harvest. These weights were obtained in connection with samples taken for residue analyses during the past 2 growing seasons. Each sample weight was expressed as its respective per cent of the harvest weight. This growth, thus expressed, was plotted against the days before the date of harvest. The growth curve was drawn through some 50 points to give the best fit by eye.

When reading directly from this type of curve the per cent of harvest weight at a given time before harvest is also the percentage of the deposit put on at that time which would be present at harvest on the weight basis if there were no weathering. If the only source of apparent loss were the increase in weight of the crop, (that is, if an application is made 20 days prior to harvest) that indicates from the curve that the plant has completed only 10 per cent of its growth. This means that by harvest time the weight of the plant will increase 90 per cent, so only 10 per cent of the residue applied 20 days prior to harvest would remain at harvest time.

For the purpose of studying the relative importance of growth and weathering on the apparent reduction of DDT and parathion residue (decrease of residue in parts per million), duplicate residue samples were taken from plots of DDT and parathion spray treatments. Residue samples were taken from each series of plots and analyzed at weekly intervals after the fourth and fifth application until harvest. The analyses gave the residue in parts per million and in micrograms per plants of lettuce. For any one series of analyses of an insecticide treatment, the percentage of weight increase could be obtained from the growth curves by reading the percentage differences between the times of the last residue sample and each of the later ones. This per cent of weight increase at any interval would also be the per cent of insecticide lost to growth. When this per cent is applied to the original deposit the resulting figure would give the apparent loss due to growth in parts per million. At any one interval the original deposit minus the apparent loss due to growth and the determined deposit would equal the loss due to weathering. That is, if the residue immediately after the last application was determined as 100 ppm and the analysis one week later showed a decrease to 10 ppm, this would mean there was a total loss of 90 ppm. From the growth curve, it was determined, say, that the weight of the plant had increased 80 per cent dur-

ing that week; therefore, 80 per cent of the original deposit would be 80 ppm. The difference between the total loss (90 ppm) and the apparent loss due to growth (80 ppm) would be 10 ppm, or that loss due to weathering.

Curves were prepared from the known and calculated data to show the relative importance of growth and weathering in the apparent reduction based on parts per million, as resulting from either factor, could be read directly from the curves as well as the per cent of the initial deposit remaining at any interval of time.

A graph was drawn for DDT wettable powder spray when this material was applied 4 and 5 times at the rate of 1 pound of DDT per acre. In reading from the graph it was noted that where 4 applications were made 92 per cent of the apparent residue loss 15 days after the last application would be due to growth. Only 6 per cent would be due to weathering and 2 per cent of the initial residue would remain. When 5 applications are made it was found that the 84 per cent would be lost because of growth, 14 per cent due to weathering, and 2 per cent would remain 15 days after application. Growth would account for more of the apparent loss when 4 applications are made than for 5 applications because of the longer interval of time the plant has to grow and increase in weight.

Similar curves were made for 4 and 5 applications of of parathion wettable powder sprays. Parathion was applied at 0.075 pound per application per acre. Fifteen days after the fourth application 82 per cent of the apparent residue reduction was due to growth, 18 per cent was due to weathering, and the per cent of the initial deposit remaining approximated zero. In following the curves for 5 applications it was found that 84 per cent was lost due to growth and 16 per cent due to weathering. *The important fact pointed out in this graph is that when parathion is applied at this concentration there is little danger of harmful residue if the last application is made 15 days prior to harvest.* Apparent loss curves based on the percentage of residue decrease in parts per million were also prepared for DDT oil emulsion sprays applied 4 and 5 times at the rate of 0.75 pound of DDT per acre.

(Continued on page 29)

How to handle AMMONIUM NITRATE

Manufacturing Chemists' Association

AMMONIUM nitrate is now one of the most important sources of nitrogen plant food for agriculture. In fertilizer-grade, it contains 33 per cent of its weight as available nitrogen. By comparison, sodium nitrate, either natural or synthetic, carries about 16 per cent nitrogen by weight, while ammonium sulfate, both by-product and synthetic, has a little over 20 per cent. Together, the three compounds comprise the major nitrogen-carrying materials now available to the farmer. At the moment, they can be obtained in almost unlimited quantities.

The present position of ammonium nitrate among fertilizer chemicals was not reached easily. The material was known for many years as a potential fertilizer, but never had been supplied in sufficient amounts or in a form which the farmer could use conveniently or efficiently. Now it is prepared in a satisfactory form, well-packaged, properly transported and stored, and is widely used as a plant food in many parts of the world.

The bulk of the ammonium nitrate made in North America is manufactured from ammonia produced in privately-owned plants, some of which were built by the federal government to supply military chemicals essential during the war. Ammonia is chemically combined with nitric acid, also made from ammonia, to form the compound ammonium nitrate. The production from the converted government plants both in the United States and Canada has made possible greatly expanded supplies for domestic use. In addition, substantial exports, both commercial and government, were made from 1946 through 1949 to areas of Army occupation and to countries served by the United Nations Relief and Rehabilitation Administration. Thus the gap between war-time scarcity of nitrogen fertilizer and the present supply was bridged chiefly by ammonium nitrate.

Formerly, ammonium nitrate, which probably came first from war surplus plant in Europe after World War I, was a very unsatisfactory material for the farmer. As shipped, it was a soft, granular or powdery material that on the slightest exposure to moist air became damp and quickly caked into bag-size chunks. The present fertilizer-grade ammonium nitrate is physically quite different. It consists of little pellets or balls of specially prepared ammonium nitrate of high purity, covered by a small amount of conditioning material. When properly bagged and stored, this material reaches the farmer in a form entirely satis-

factory for application with the customary farm machinery. The manufacturers of fertilizer-grade ammonium nitrate utilize a special type of bag for packaging, which provides good protection for the contents until the farmer opens the container.

Manufacturers' transportation and storage problems have been solved by extensive research and development. Producing plants now operate practically year round in order to supply the material at the lowest cost. But the farmer uses this, just as other fertilizers, seasonally, at the time known to be best for increasing crop production. Producers store large quantities for long periods, as do dealers and distributors. In order to insure that both transportation and storage are properly handled, investigations have been conducted as to proper carloading, ship stowage and warehouse storage. Well-packaged ammonium nitrate produced for fertilizer will withstand this handling and storage without deterioration.

One of the major problems connected with the distribution and use of fertilizer-grade ammonium nitrate has been the apprehension which resulted from the disastrous ship explosion at Texas City, Texas, in 1947, (*See* AMERICAN FERTILIZER, ***April 19, 1947***), in which a form of fertilizer-grade ammonium nitrate was involved.

A complete review of the experience in handling millions of tons of the material, both as rail freight and ship cargo, has demonstrated that the safe handling of this product requires the same kind of precautions as those which have been well-established for the safe handling of other oxidizing materials. Such a review was made by a group of experts drawn from producers of ammonium nitrate and experienced in its manufacture, transportation, and handling, and the results published by the Manufacturing Chemists' Association.

You can get a complete manual on the properties and recommended methods for the packaging, handling, transportation, storage and use of fertilizer-grade ammonium nitrate from Department 9, Manufacturing Chemists' Association, 246 Woodward Building, Washington 5, D. C. Ask for Manual A-10. Price: 50 cents.

The fires and explosions aboard ship at Texas City resulted, these experts report, from improper handling and ineffective fire-fighting. Further along in this article, the experts give their interpretation of the Texas City disaster.

Ammonium nitrate is classed chemically as an oxidizing material. This means that the oxygen which it contains can support combustion if it is involved in a fire with combustible materials. Like other chemicals of this type, the material must be so stored and handled that it does not become mixed with other products that will burn. With simple precautions, fertilizer-grade ammonium nitrate can be stored safely at the factory, in distributors' warehouses, or on the farm. As in the case of gasoline which can form explosive mixtures with air, or insecticides which may be toxic, ammonium nitrate deserves common-sense treatment during transportation, storage and use.

It is understandable that as a result of the Texas City disaster, emergency regulations of an extremely restrictive nature were imposed. But, during rail movements there has never been an instance in which ammonium nitrate has contributed an unusual difficulty in the case of derailments, fires or handling. In recent years, several million tons of fertilizer-grade ammonium nitrate have been transported on this continent by rail.

The large part of these shipments consisted of granular ammonium nitrate coated with a few per cent of non-combustible mineral matter, or this mineral plus about one per cent of an organic wax-like substance. Practically all these shipments were made in carload lots, packed in one-hundred pound capacity multi-wall paper bags. These shipments moved considerable distances under the usual condition of rail transportation and were not accorded preferential handling or precautions other than those normally observed for regulated articles in this class of freight. As reasonably could be expected in the movement of this tremendous tonnage, a few of these shipments were involved in mishaps such as derailments, collisions and fires. In not a single instance did any of these accidents result in an explosion.

The Bureau of Explosives, an officially recognized technical agency to develop and enforce safe methods for transportation, investigated these accidents in detail with special attention given to those cases which resulted in fires. The records of the Bureau show that there have been several fires in carload shipments of bags of fertilizer—grade ammonium nitrate which were caused by "hot-boxes"; ignition of cars and contents from external sources such as brush fires, sparks, and so forth; and one instance in which a car was set afire by an acetylene torch during the clearing of a wreck. These fires completely consumed the cars and contents in some cases while in others they were extinguished by application of water with only partial loss of lading and damage to cars. Even those cars of nitrate at shipside at Texas City which became ignited merely burned.

Here is a brief review of some of these typical fires involving railway shipments:

1. A wooden boxcar fully loaded with about 1200 bags of fertilizer-grade ammonium nitrate was struck by a steel hopper car during a switching operation in a railroad yard. Both cars were derailed and so badly damaged and tangled that unloading was impractical and it was necessary to cut some of the gear with an acetylene torch to make possible the removal of the cars with a wrecking crane. The boxcar and contents caught fire during this operation and the repair crew attempted unsuccessfully to put out the fire with a soda-acid extinguisher while waiting for the local fire department. The fire spread rapidly and the car was

completely enveloped when the local fire department arrived and applied a hose stream. The fire had made such headway that it could not be brought under control and the entire lading was destroyed and the car structure badly damaged.

2. Smoke was seen coming from a boxcar partially loaded with bags of nitrate, which was standing with doors open in the loading yards after workmen had stopped loading for a rest period. This fire burned slowly for some time without becoming intense and was finally extinguished with water from a deluge pump.

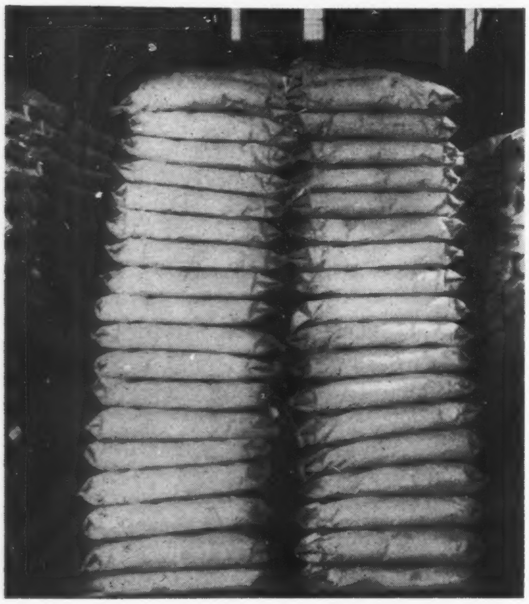
3. A "hot box" was observed enroute on a boxcar containing about 1100 bags of ammonium nitrate fertilizer and the car was set out of the train on a siding. Shortly afterward, the fire had spread to the wooden structure and had contacted the lading before the local fire department arrived. Water was applied and the fire extinguished when about half the lading had been destroyed and considerable damage done to the car structure. Approximately one-half the lading was salvaged in usable condition.

4. A train carrying several cars loaded with fertilizer-grade ammonium nitrate was standing in a yard when a brush fire developed adjacent to the tracks. As wind was blowing vigorously from the fire toward the loaded cars, it was isolated and the local fire department called. The fire developed such intensity that efforts to extinguish it failed and the lading was completely destroyed.

5. A carload of bagged fertilizer-grade ammonium nitrate was moving in a train made up of miscellaneous freight which included a number of cars of gasoline. Several of the cars were involved in a serious derailment that caused rupture of some of the gasoline cars. The gasoline ignited in a fire that was visible for several miles. The car of nitrate also became ignited and burned completely with entire loss of the lading and car. It was not practical to attempt fire-fighting efforts on this car.

Freight cars for shipping ammonium nitrate should be cleaned and protruding nails removed. Then inside of car lined with paper up to height of load

This is the recommended way to pile fertilizer-grade ammonium nitrate in storage and warehouse. Note the spaces between the piles for easy access in case of fire or other emergency that may develop in the area



These are brief accounts of typical transportation accidents which resulted in fires. In some of these cases the lading was subjected to severe and unusual mechanical shock. Detailed investigation of these and other fires, and subsequent laboratory examination, have failed to indicate that any of these fires were caused by spontaneous heating of the nitrate. The incidents outlined are representative of the experience in rail transportation accidents in which nitrate was involved.

Safe transportation of fertilizer-grade ammonium nitrate involves, first, good loading practices. In rail transportation, good carloading practice requires proper preparation of the car, correct placement of bags and suitable care to prevent shifting during transit.

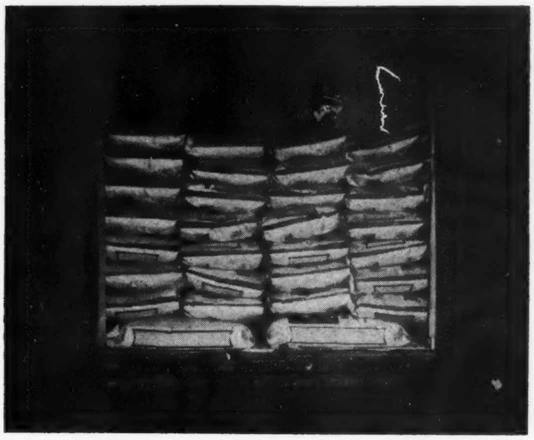
Cars must be first inspected and accepted or rejected according to their condition. They must be without leaks and free from extraneous combustible material such as coal, carbon black, oil and sulfur. Projecting nails must be removed to prevent tearing of bags.

Under good loading practices the floor is then covered with car lining paper and in some cases this lining paper is extended on the walls of the car to the height of the load, particularly if the inside of the car is rough. In addition, strawboard or paper is placed around the door frames to prevent tearing of the bags at these points.

Load patterns may be worked out on actual carloading experience, both to equalize the load throughout the car and to insure a minimum shifting of the bags during transit.

Each loading pattern is governed by the dimension of the car, size of the load, and arrangement of the bags. As all three factors can vary considerably, it is obvious that there may be a large number of loading patterns. Whichever pattern is used, the bags are loaded into each end of the car in identical arrange-

Load patterns worked out in advance help equalize weight; minimize shifting of bags during transit. Man above demonstrates standard loading practice



Two bags placed lengthwise at each side of door help shift weight toward center, making for less strain and easier access to doors upon arrival

ment and are placed in the bulkhead in such a way as to shift the weight of the bags to the center of the car instead of the ties. This results in less strain on the doors and permits every door opening at the car's destination.

Empty over-size bags may be used for overslipping in case any bags are broken or torn in transit. Spilled material must be swept up and carefully disposed of. In both loading and unloading operations, observance of the following precautions is important:

Keep away from heat and open flame.
Do not store with combustible materials.
In case of fire, flood with water.
Burn empty bags promptly in the open
Place broken or torn bags and contents in overslip bags.
Sweep up and dispose of all spilled material immediately.
Do not rebag loose material.

The above precautions usually appear on the face of each bag of ammonium nitrate fertilizer as part of the informative label recommended by the Manufacturing Chemists' Association. A second cautionary label is the familiar yellow one prescribed by the Interstate Commerce Commission.

Various types of door-gates for freight cars are used by different producers. Some shippers use heavy paper, reinforced with steel strapping, nailed across the doors at regular intervals. Others use lumber with a facing of paper in the same manner. The main purpose in all cases is to prevent damage to the bagged material at the doors.

Proper methods for storing fertilizer-grade ammonium nitrate are, like those for shipping the material, matters of common sense based on experience. A number of fires involving stored ammonium nitrate fertilizer have been reported. Here again, ammonium nitrate of fertilizer grade did not prove to be an exceptionally hazardous substance. In only one case did a fire involving stored ammonium nitrate originate in or near the fertilizer material itself. In most cases the fires occurred in rural areas—barns or farm storage buildings—remote from adequate water supply for fire fighting. As a consequence, the buildings were generally badly damaged or destroyed. In some instances, a portion of the stored fertilizer material was not destroyed despite the fire around it.

Among the most significant fires reported was one in a large warehouse where more than a thousand tons of fertilizer-grade ammonium nitrate was stored. A detailed study of this fire reveals that the fire originated in an adjacent building which contained alfalfa meal. The fire spread to the warehouse containing the nitrate, but although the building was a complete loss, approximately ten per cent of the fertilizer was saved by effective fire fighting methods.

The single instance in which fire originated in fertilizer material containing ammonium nitrate occurred in a mixture of this fertilizer with organic materials and uncured superphosphate. The bulk storage of this mixed material resulted in internal heating of the pile, which was followed by fire. Manufacturers caution against such mixing, both for safety and to avoid waste. Such mixtures are almost certain to lose some of the valuable plant food constituents which have been added in the components, because of reaction between the material mixed. Investigation of all commercial and farm storage fires does not reveal a single case in which an explosion of ammonium nitrate occurred.

Warehouse storage of fertilizer-grade ammonium nitrate is of particular interest to producers and distributors because, while the product is turned out on a year-round basis, farmers are reluctant to buy it until they intend to use it. As in the case of many other commodities, fertilizer-grade ammonium nitrate should be stored on a

clean floor and in a well-ventilated structure. It should be readily accessible, and stored away from electric wiring, steam pipes, radiators, explosives, organic materials, acids and easily oxidized materials.

The precautions and recommendations listed on the bag labels (see above), should be particularly observed. Smoking must not be permitted in a warehouse or in the area surrounding it. As a matter of economy, it is important that the material be protected from container breakage, spillage, and access to moist air.

The following storage recommendations, adapted from the proceedings of the conference on Ammonium Nitrate Fertilizer of the National Research Council of Canada, are considered to be good practice:

1. Bags of ammonium nitrate fertilizer should be stored not less than 30-inches from the storage building walls in piles not more than 12-feet in width, with 30-inch aisleways between the piles. Bags should not be stored closer than 36-inches from the eaves of the roof or supporting and spreader beams overhead.
2. Roofs and floors above masonry or concrete walls should be of light weight construction and should not be of concrete or masonry. Wooden structures are considered safe.
3. Ammonium nitrate fertilizer should not be stored in any structure in which any explosives are kept.
4. Warehouses or structures used for storage purposes should be clean, and be maintained in good housekeeping order.
5. Ammonium nitrate fertilizer should not be stored over or under any organic chemicals, inflammable liquids, corrosive acids, chlorates, permanganates and the like, finely divided metals, sulfur or combustible material other than dunnage. Storage piles should be at least 30-feet away from these materials.
6. The material should not be stored closer than three feet from steam or hot water pipes, radiators, heating devices, or electric wiring and fittings, including switches.
7. Ammonium nitrate fertilizers may be stored on clean concrete floors or wood platforms or dunnage on any type of clean floor. Floor drains into which molten nitrate can run during a fire should be eliminated or plugged.
8. Spilled material should be cleaned up promptly and disposed of. A broken or cracked bag containing uncontaminated fertilizer may be salvaged by placing it inside a clean new over-slip bag and closing securely.
9. Except at fertilizer manufacturing plants, ammonium nitrate fertilizer should be stored only in containers.
10. Smoking should not be permitted in or near storage spaces.
11. Open lights or flames should be prohibited in or near storage spaces.
12. Fire hydrants, exterior of the storage spaces and conveniently placed, with adequate hose available and capable of extension to all parts of the storage, should be provided.

When ammonium nitrate is heated 70 to 80 degrees above its melting point of 337° F., it begins to decompose into nitrous oxide (laughing gas) and steam. It gives up a small amount of heat. The decomposition starts very slowly about this temperature (410° F. to 420° F.), but becomes increasingly vigorous as the temperature is raised. All of the nitrous oxide of commerce is produced by this simple decomposition of special grades of ammonium nitrate in reactors which usually must be heated to keep the process going at the desired rate. The decomposition is a well-behaved chemical process at temperatures up to about 500° F., at which point it becomes too rapid for easy control.

At temperatures between 500° F. and 550° F., the decomposition products begin to include free nitrogen and oxygen, and the amount of heat given up increases about four times. As any chemical process which produces gas and an appreciable amount of heat is potentially explosive, there are conditions under which the high temperature decomposition of ammonium nitrate will proceed at an explosive rate or may produce explosive effects.

If a dynamite charge or other

(Continued on page 30)

Clean, dry samples are placed in racks to await testing which requires but minute portion of soil.

New Jersey Soil Testing Plan

Mike Brodine

Photos by the author

Solutions extracted from submitted samples are divided electrolytically into ions of the different elements contained in the sample. The ions can then be identified as to kind and quantity by instruments like this flame photometer, which is normally used at Rutgers in testing for phosphorous ions.

THERE IS NO hard and fast rule upon which all fertilizer recommendations can be made. That is the central fact behind the New Jersey Plan for Soil Testing. Simply stated, the plan—developed by Dr. E. R. Purvis and his staff at the New Jersey Agricultural Experiment Station—includes the County Agent as an integral part of the soil testing procedure.

In the past, most farmers have "pulled" their own samples and sent them directly to the laboratory for recommendations as to the proper fertilizer for their land. The basic weakness of that method, as Dr. Purvis sees it, is that laboratory tests can show only what was in the sample, and that is only part of the story. The lab tests have to be correlated with actual field tests if the needs of a particular crop on a given field are to be met.

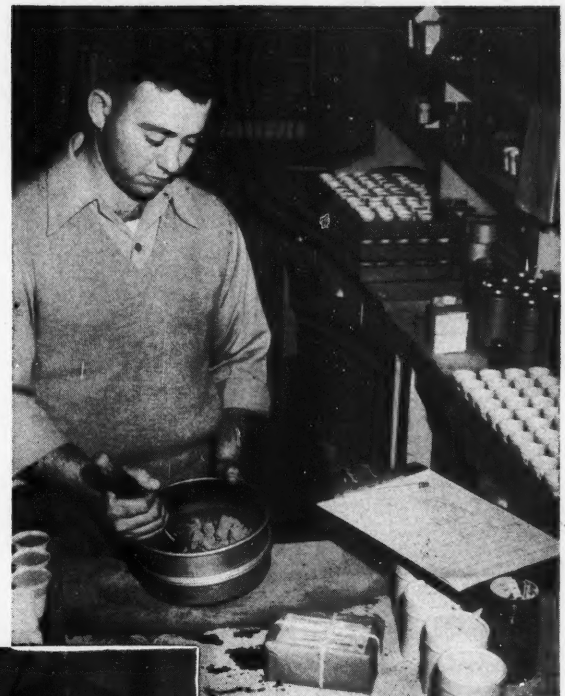
In the New Jersey plan, the farmer takes his sample to his County Agent, who notes its texture, then dries and sieves the sample, marks it properly, and sends it to the laboratory. Besides leading to more useful recommendations, this step cuts down the work needed at the lab and so helps get the analysis back to the farmer more quickly. The lab sends the analysis to the County Agent who makes the fertilizer recommendations according to what has been grown in the field previously and what the farmer intends to plant there.

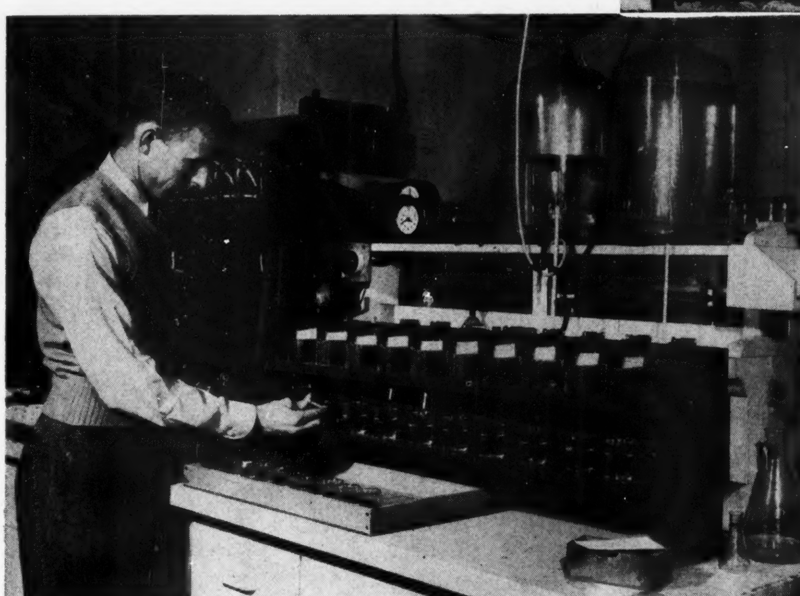
To supplement the specific analysis made at the lab, Dr. Purvis' staff issues periodical instructions to help the County Agent make the best possible recommendations. In this way, the New Jersey plan for soil testing should lead to better use of the most appropriate fertilizers available.

The procedures followed at the Rutgers laboratory under Dr. Purvis are as unique as the general method for getting the samples to the lab in the first place and for increasing the value of the analyses after they get back to the farmer. For one thing, workers at the New Jersey Agricultural Experiment Station soil testing lab have revamped an old method of analyzing solutions and have applied it to soil-testing. Other soils-testing labs use a chemical extraction method that is relatively slow. Rutgers is the only soils lab known to use an electrolytic extraction method. The method, known as electro-dialysis, separates the positive ions from the negative ions in a solution. The method itself is old, but its application to soils-testing and a modified, smaller, and more efficient electrical cell that cuts down the time required to make an analysis, are innovations made at the Rutgers laboratory in New Brunswick, New Jersey. Extractions that formerly took 12 hours employing the older type cell can be made in 20 minutes with the Rutgers version of the cell.

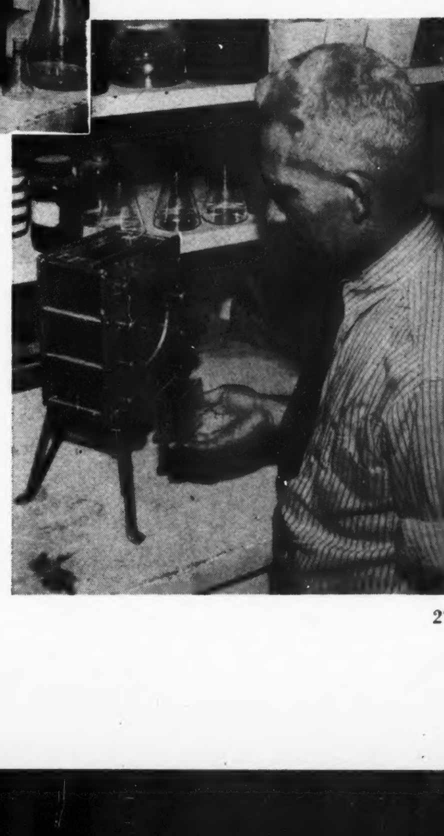
Soil to be tested is first dried, pulverized, and sieved. Then a small portion of the sample is placed within filter paper and inserted in the central compartment of the cell which is then filled with a mildly acid electrolyte. When electrical current, usually of less than 0.2 amperes at 100 volts, d.c., is applied to the cell, positive (metallic) ions (electrically charged particles in solution) gather in one half of the cell and negative (non-metallic) ions gather in the other half.

After the solution has been split into its metallic and non-metallic ions, its various components are identified both as to kind and quantity in a series of standard chemical tests. A flame photometer, *see cover*, is used to test for potassium. Phosphorus and magnesium are identified by color tests and the *p*H of the soil is determined by the glass-electrode method. Other substances are tested for only on special request or on trouble-shooting jobs. ◆





Preparing soil for testing (above) takes valuable lab time and Rutgers hopes to eliminate this step. Draining the extracted solutions from the cells following electro-dialysis will be faster after new arrangement (left, rear), that will drain entire bank of cells at once, is put into operation. The difference between the old type cell and the Rutgers version can be seen from the picture below. Smaller cell greatly speeds up operations.

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FLAT SEWN VALVE
PASTED VALVE
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Truitt New APFC President

Successor to Woodrum Experienced Trade Association Executive

Paul T. Truitt

PAUL T. TRUITT, nationally-known trade association executive and businessman, has been elected president of the American Plant Food Council, Inc., the Board of Directors of the organization announced today.

He succeeds the late Clifton A. Woodrum, for 23 years a member of Congress from Virginia, who died October 6, 1950.

"As president of the Council," Mr. Truitt said, "I shall endeavor to further the organization's aims and purposes with special emphasis on the all-important problem of maintaining, replenishing and increasing the fertility of our soil."

At the time of his election Mr. Truitt was president of the National Association of Margarine Manufacturers, a position he has held since 1943. Previously, Mr. Truitt had been an executive with Sears, Roebuck & Co., and had been an official of the Treasury Department and of the Department of Commerce.

His work with the National Association of Margarine Manufacturers has attracted wide attention in business and government fields and in 1949 the Association, under his leadership, was given the Public Relations News Annual Achievement Award for excellence in public relations programs.

"We feel fortunate," said W. T. Wright, of Norfolk, Va., chairman of the executive committee of the Plant Food Council, "in obtaining the services of an outstanding man like Mr. Truitt. Wherever he has worked, he has built an enviable reputation for integrity, industry, ability and achievement. I know Mr. Truitt is looking forward with zest to helping the membership of the American Plant Food Council aid agriculture. Our job is to help improve the land and to raise better crops. Both are in the public interest, and each is a part of our first line of national defense."

Mr. Truitt was born in Millersburg, Missouri, on October 25, 1900. He was graduated in 1924 from the University of Missouri where he studied agriculture and business administration. He married Jonnabelle Hunt, of Kansas City, Missouri, in 1928.

He is a member of the Metropolitan Club, the Burning Tree Club, and the Congressional Country Club, of Washington. Mr. Truitt's home address is 6538 Lenhart Drive, Chevy Chase, Maryland.

Pivoted Fork Improves Lift Trucks

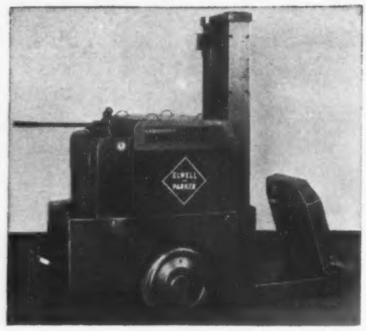
Vertically pivoted forks for use on high-lift power industrial trucks have been developed by Elwell-Parker Electric Co., Cleveland, to meet requirements in factories, warehouses and shipping departments where loads frequently are maneuvered in congested areas. The device is furnished as an integral part of some models of Elwell-Parker fork trucks, or may be supplied as an attachment for standard model fork trucks. The tines are used either in the ordinary way or may be quickly adjusted for unusual conditions relating to size of position of the load.

Each tine of the fork is adapted to swing inward from normal straight forward position, facilitating its entrance into a pallet or under a skid. The tines may be set so their points almost come together in the form of a V, or so

that one tine remains in normal position while the other is moved over far enough for the outer end to touch it.

With either adjustment it is not necessary for the truck and pallet to be in alignment as a preliminary to lifting or depositing a load. The truck may approach and handle a load at an angle of as much as 45 degrees from parallel, depending on length of tines and width of pallet.

The head of each tine has two cross-members supported horizontally in a fixture bolted to the base plate attached to the truck's elevating mechanism. The inner cross-member is held in the fixture by means of a vertical pin forming a hinge, and under tension of a spring. The outer member is a short length of steel bar and normally rests in a contoured flange welded to the base plate. The tine is adjusted simply by moving it sideways, spring tension holding it in position pointing either inward or straight ahead. All parts are made from forged alloy steels and machined for precision fit and guaranteed against breakage up to full truck-load capacity. ◆



New Lift Has Pivot Fork

Ericson Appointed Purchasing Agent by Consolidated Rendering

Victor A. Ericson was appointed Purchasing Agent of Consolidated Rendering Co., Boston, Mass., on January 2, succeeding Edwin A. Simpson, who is retiring after 39 years' service with the company.

Mr. Ericson, who has filled the position of Assistant Purchasing Agent for the past 10 years, will have charge of all purchases of plant equipment, motor vehicles, fertilizer materials and supplies of every description, for the parent companies and its subsidiaries.

William C. Potter, formerly in the General Office Chemical Laboratory, has been appointed as assistant to Mr. Ericson.

Tax Tag Sales Record Broken

New fertilizer tax tag sales records are assured for 1950. Sales for the first 11 months in 1950 have exceeded the full year of 1949 by 224,000 equivalent tons. December figures from 12 of the 14 reporting States show an increase of 40.3 per cent over December, 1949.

January-November figures for the 11 southern States and 3 midwestern States add up to a bit over 10,000,000 equivalent tons. This is an increase of 9 per cent over the like period last year.

Gains were registered during the fertilizer year to date. July-November figures show a gain of 23 per cent in the South, 18 per cent in the Midwest and 21 per cent for the whole group over comparable 1949 figures.

FERTILIZER TAX TAG SALES AND REPORTED SHIPMENTS
(In Equivalent Short Tons)
COMPILED BY THE NATIONAL FERTILIZER ASSOCIATION

STATE	NOVEMBER		DECEMBER		JANUARY-NOVEMBER		JULY-NOVEMBER	
	1950	1949	1950	1949	1950	1949	1950–51	1949–50
Virginia	20,189	13,569	6,488	26,773	663,842	655,642	152,060	161,655
N. Carolina	——	38,123	——	68,473	1,708,744	1,449,984	283,950	189,098
S. Carolina	83,355	49,598	94,856	52,404	918,970	910,312	213,355	147,740
Georgia	88,684	45,493	62,248	44,927	1,173,510	1,188,708	217,205	172,286
Florida	148,351	112,455	120,795	126,073	976,573	858,019	406,425	342,556
Alabama	56,085	42,522	59,025	29,581	992,284	1,012,788	167,989	135,936
Tennessee	37,513	27,177	16,316	13,691	475,940	448,084	103,202	87,352
Arkansas	12,622	14,650	22,201	18,050	343,862	316,545	53,732	49,368
Louisiana	17,813	11,292	13,226	10,590	265,482	230,999	61,001	45,854
Texas	43,458	52,923	37,877	28,036	549,762	477,461	218,232	187,613
Oklahoma	——	2,307	——	3,330	137,430	122,198	49,118	51,188
Total South	——	410,109	——	421,928	8,206,399	7,670,740	1,926,269	1,570,646
Indiana	97,590	62,916	148,725	98,264	812,928	672,475	347,439	307,155
Kentucky	31,240	29,754	76,175	53,710	530,995	437,006	131,588	112,337
Missouri	8,491	2,010	72,885	18,664	483,010	435,727	190,295	149,320
Total Midwest	137,321	94,680	——	170,638	1,826,933	1,545,208	669,322	568,812
Grand Total	——	504,789	——	592,566	10,033,332	9,215,948	2,595,591	2,139,458

Residue Studies

(Continued from page 20)

There curves followed the same trend as did the DDT wettable powder curve, one difference being that the DDT emulsion formulation seemed to be less affected by weathering. This was evidenced in the graph as the curve denoting the per cent of the initial deposit remaining at any one interval of time did not drop off as rapidly as it did in the case of DDT wettable powder.

The idea might develop from the apparent loss graphs that weathering has little effect on the apparent reduction of residue on lettuce. This is true in the case of the apparent reduction as determined in parts per million because the increase in weight of the plant is so great from the time of the last application until harvest. However, in the actual loss of residue, weathering does play an important role.

The actual loss of residue was figured out, for all of the materials tested, on the basis of the micrograms of insecticide found in each sample. The per cent loss, figured on the basis of micrograms, varied considerably, as might be expected but did follow a trend that could be plotted graphically.

When curves denoting the actual loss of DDT and parathion were plotted (that is the actual decrease in the deposit of insecticide in micrograms during any interval of time) it was found that approximately 90 per cent of the initial deposit would be lost due to weathering 15 days after the last application. This approximate 90 per cent loss applies to the concentrations of DDT and parathion wettable powders and DDT emulsion sprays used in these experiments. The magnitude of this figure shows that weathering, too, plays an important role in the actual loss of residue on lettuce. Therefore, it is evident from the 2 types of curves that 90 per cent of the actual insecticide deposit will be lost due to weathering 15 days after application and some 80 to 90 per cent of the apparent residue will be "lost" due to growth. The latter being merely because of the increase in weight of the plant. ◆

Tennessee Eastman Changes Corporate Structure

On January 1st, Tennessee Eastman Corporation, wholly-owned subsidiary of Eastman Kodak Company, was dissolved as a separate corporation and will be conducted as a division of the parent company. The business operated at Kingsport, Tennessee, will be continued in the name of Tennessee Eastman Company Division of Eastman Kodak Company.

The division will continue the same manufacturing, selling and other activities with no change in personnel or policies. Among the products manufactured at this plant is manganese sulphate, which is marketed under the trade name of "Tecmangam."

Moore Elected Royster Vice President

On December 12th, F. S. Royster Guano Company announced the election of Frank S. Moore to the office of Vice President. Mr. Moore had previously served as Assistant to the Vice President.

Ammonium Nitrate

(Continued from page 24)

explosive primer is detonated in ammonium nitrate or in mixtures containing large proportions of it, an explosion may result. In this case, the localized rate of heating of the ammonium nitrate by the primer or explosive is extremely rapid.

Under certain conditions, an explosive rate of decomposition may be established very quickly by such use of dynamite. At Oppau, Germany, in 1923, blasting with dynamite started an explosive decomposition of ammonium nitrate and ammonium sulfate. This mixture was obviously very difficult to decompose for, according to the records of the company involved, the pile had been dynamited thousands of times before the single explosion occurred. Other explosions of materials containing large proportions of ammonium nitrate have been reported as having been caused by explosives. Therefore, under no circumstances should fertilizer-grade ammonium nitrate be exposed to the action of dynamite or other explosives.

When ammonium nitrate is heated to a high temperature in a bomb or other closed container which retains the products of decomposition *and the heat of reaction*, the temperature and pressure may suddenly rise dangerously and may result in an explosion. Fertilizer-grade ammonium nitrate should, therefore, not be heated when confined. In this respect, ammonium nitrate is similar to many other materials, water, for instance, which develop high pressures when heated under confinement.

There have been a large number of fires involving granular ammonium nitrate and materials containing it, including various fertilizer types of ammonium nitrate. With two widely noted exceptions no explosions have resulted from fires of fertilizer-grade ammonium nitrate. One of these exceptions was the instance in which two Liberty ships, the *S.S. Grand Camp* and *S.S. High Flyer*, burned and exploded to cause the tragic Texas City disaster of April 16 and 17, in 1947. The other also involved a Liberty ship, the *S.S. Ocean Liberty*, which burned and then exploded off Brest, France, in July of the same year.

It should be recognized that a number of conditions which would be expected to contribute to the development of an explosion evidently existed on each ship. The particular variety of wax-coated fertilizer-grade ammonium nitrate contained one per cent of combustible material and so developed appreciably more heat and gas than the inert-coated type now usually sold. Furthermore, the material was stowed solidly into the holds so that at various stages of its progress the original fire could have burned under conditions of confinement that would lead to explosive burning. The holds in the vessels were, in effect, fire-resistant boxes with restricted outlets for the gases and heat. In each shipboard explosion, the tragic lack of effective fire-fighting measures permitted the fires to grow to uncontrollable proportions.

Fortunately, the conditions of land transportation and storage do not involve the factors that may have contributed most to the ship explosions. In fact, railroad cars loaded with nitrate which were beside the *Grand Camp* were not exploded even when this ship did explode. The conditions necessary for an explosive fire are rather easily eliminated from the ship transportation of fertilizer-grade ammonium nitrate. The methods of handling and storage described in the pamphlet prepared by the Manufacturing Chemists' Association were developed to eliminate such factors.

In a matter as controversial as the interpretation of the Texas City disaster, it is inevitable that many opinions or conclusions, and attempted interpretations of observations during experimental work, should have been published. An effort has been made by the authors of this material to summarize those conclusions which seem to be well established and substantiated as facts. Many other opinions and interpretations which have been published appear to be wholly unwarranted. For example—and contrary to public statements that have been made on the subject:

There is no evidence that hydrazoic or fulminic acid or other explosive materials are formed in ammonium nitrate during manufacture or storage.

The experience of manufacturers indicates that no hazard exists due to spontaneous combustions of fertilizer-grade ammonium nitrate when properly manufactured or handled.

There is no substantiated record of explosions of unconfined fertilizer-grade ammonium nitrate due to heat or fire alone.

There is no basis for the various theories that ammonium-nitrate is "sensitized" or rendered danger-

(Continued on page 40)

FERTILIZER MATERIALS MARKET

New York

January 3, 1951

Sulphate of Ammonia

With one possible exception, all the large coke oven producers have raised their price of this material for spot and future sales on an average of about $8.00 per ton. While most buyers are under contract at the old contract prices, the demand has increased recently from various directions.

Nitrate of Soda

No price change has been noted so far in this material and a better movement was noted in most sections.

Ammonium Nitrate

The price of this material has advanced recently at leading production points and demand continues heavy. Some producers are behind on shipments.

Nitrogenous Tankage

This material is in heavy demand from all sections and domestic producers are sold out. In some cases, due to difficulty in obtaining raw material, they may be forced to cut back their contracts.

Castor Pomace

The demand for this material has increased considerably recently and producers have now sold a large part of their anticipated production for the next 60 days. Because of the difficulty they have in obtaining castor beans, it is expected their production will be cut considerably within a short period.

Organics

Organics in general remained firm in price and the demand was excellent from both feed and fertilizer buyers who wanted to be sure of getting the supplies they need for the coming season. Cottonseed meal showed renewed strength and was quoted nominally at $84.00 per ton, f.o.b. Memphis for 41 per cent protein material in bags. Soybean meal was quoted at $62.00 per ton in bulk, f.o.b. Decatur, Ill. Even linseed meal, which has been in poor demand, picked up the past few weeks and is now quoted at $66.00 per ton in bulk, f.o.b. Eastern points. Last sales of tankage were made at $8.50 per unit of ammonia ($10.33 per unit N), and blood sold at $9.00 per unit of ammonia ($10.94 per unit N), f.o.b. New York.

Fish Meal

Both menhaden fish scrap and meal were not too plentiful for nearby shipment but numerous arrivals of foreign material at various ports helped the supply situation considerably. Prices for the meal ranged from $125.00 per ton to $140.00 per ton, according to quality and test.

Bone Meal

Demand for this material has increased over the past week and some domestic producers have withdrawn from the market. Feed demand has been very heavy, particularly from the Midwest. It is understood that ocean freight rates are advancing, which should have a tendency to stiffen the price of imported feeding bone meal.

Hoof Meal

Last sales made at $7.25 ($8.82 per unit N), f.o.b. Chicago, and demand is good.

Superphosphate

This material has been advanced in price all along the Atlantic Coast due to higher raw material costs. Demand is good and some plants are considerably behind on shipments. Triple superphosphate is still hard to obtain unless a buyer has a contract.

Potash

Foreign material continues to arrive at various Atlantic ports at prices comparable with the domestic market. Here and there are reports of temporary shortages and some domestic producers are still having some difficulty in securing necessary box cars to make shipments.

Philadelphia

January 3, 1951

The general market for raw materials is getting stronger and the new year is opening with higher prices than prevailing in the recent past. Interest in resale material is growing steadily.

Sulphate of Ammonia.—Shipments of coke-oven grade are moving in good volume against contracts which about take care of the full production. There is quite a little inquiry for resale, but very little offering. Synthetic grade is in exceedingly tight supply and priced higher.

Ammonium Nitrate—Production is heavily under contract with the demand far ahead of supply, and market is very strong. Some resale material has been moved at premium prices but offerings are exceedingly light.

Nitrate of Soda.—Market is firm and the demand more active as the prices of other forms of nitrogen continue to advance. Supply is ample for the present.

Blood, Tankage, Bone.—Buying interest in blood and tankage has improved but price range remains about the same—$8.25 to $9.00 per unit of ammonia ($10.02 to $10.94 per unit N), depending on location. Bone meal is quoted at $65.00 to $67.50 per ton, depending on grade.

Castor Pomace.—Movement has been limited to a few sales at $5.50 per unit of ammonia ($6.68 per unit N), in bags.

Fish Scrap.—Market remains steady with menhaden meal quoted at $130.00 to $135.00 per ton, and scrap at $130.00.

Phosphate Rock.—Market is strong and full production is moving against contracts with supply keeping well up with requirements.

Superphosphate.—Triple grade continues in exceedingly tight supply position with price advance of three cents per unit scheduled for

January 1st. Normal grade is presently also in tight supply and shipments have materially increased.

Potash.—While production continues at capacity, shipments are subject to intermittent delays due to car shortage. Movement is principally against standing contracts and no free offerings are in evidence.

Charleston

CHARLESTON, January 4, 1951

All major fertilizer ingredients are now in strong demand and relatively tight market position. Prices are remaining relatively stable but increases due to higher costs of production are beginning to appear. Indications are that there will be no difficulty in selling whatever mixed fertilizers that can be manufactured during the season.

Organics.—Demand is now quite strong for fertilizer organics with supplies exceedingly tight. It is reported that a major producer of sludge tankage has been forced to cut outstanding balances on contracts considerably due to production difficulties. Producers of domestic nitrogenous tankage are completely sold up for the season. Practically all imported nitrogenous tankage has been taken up with offerings scarce.

Castor Pomace.—Limited supplies are offered for January and February shipment with one producer reported accepting small orders for March. This is for material testing minimum 5.75 per cent ammonia and the price is $5.50 per unit of ammonia ($6.68 per unit N), in bags, f.o.b. Northeastern shipping points.

Dried Ground Blood.—The New York market is nominal at around $8.75 to $9.00 ($10.63 to $10.94 per unit N), with the Chicago market steady to firm at $9.25 ($11.24 per unit N) delivered Chicago area.

Potash.—Movement continues heavy, hampered occasionally by boxcar shortages. Demand is strong and mines operating at capacity level.

Ground Cotton Bur Ash.—Supplies continue limited with light offerings in the market for January and February shipment of material testing 30/40 per cent K_2O.

Phosphate Rock.—Demand continues satisfactory for movement against contracts. Supply position is comfortable.

Superphosphate.—Triple superphosphate supply lags considerably behind the terrific demand. The producers at East Tampa, Florida, have advanced the price to 87 cents per unit of A.P.A., effective January 1. Supplies of normal superphosphate are also extremely tight with only limited quantities being offered in the East. Current price is around 81 to 84 cents at Eastern origin points.

Sulphate of Ammonia.—The market position is tight with shipments confined primarily to contract customers.

Ammonium Nitrate.—Prices for domestic production are now $61.00 to $63.00 per ton in bags, f.o.b., works. Canadian production has been advanced to $69.50, f.o.b. works. The market is extremely tight.

Nitrate of Soda.—Demand is strong and strengthening. Effective January 1 the price at the ports has been increased $2.00 per ton. The price of domestic nitrate of soda at the time of this report has not been advanced.

New Company To Develop Sulphur Deposits

Sulphur deposits and phosphate lands in Wyoming will be developed by the Continental Sulphur and Phosphate Corporation, a newly-formed company, whose headquarters are in Dallas, Texas.

The sulphur deposits are said to show a supply adequate for at least 30 years at a production rate of 200 tons per day. A plant for processing the ore will cost an estimated $2,000,000. Phosphate reserves, which are at Lander, are believed to contain 20,000,000 tons, based on a United States geological survey. A plant to produce 200 tons per day would cost approximately $3,750,000. Bids for both plants have been received, and a market has been found for their entire output.

In its development program, Continental Sulphur and Phosphate is seeking aid from the USDA, the Department of the Interior and the Reconstruction

AEC Making Survey of Fertilizer Industry

Sheldon P. Wimpfen, former editor of "Mining Congress Journal," is now on the staff of the Manager of the Raw Materials Operations of the Atomic Energy Commission, where he is making a study of the fertilizer industry. It seems that many of the raw materials for fertilizers may also contain products of value in the atomic energy program. If so, the materials would still be available to the fertilizer industry after they had been processed.

Weed Control Conference

plays host to 300 Northeastern Experts

WEED CONTROL scientists are making agricultural history according to Dr. Roy I. Lovvorn, Head of the Division of Weed investigations of the United States Department of Agriculture, guest speaker at the Northeastern States Weed Control Conference in the Hotel New Yorker, in New York City, January 3-5.

"Over 25 million acres of land were sprayed with 2,4-D alone during the last year. The discovery that 2,4,5-T kills many hardwood species not controlled by 2,4-D has revolutionized the practice of destroying brush on rangeland and along highways, railroads, power lines, telephone lines, ditchbanks and canal ditches. Interest in weed control also reaches into the field of public health through the effects of such plants as poison ivy and ragweed."

"Every state experiment station in the country with two exceptions now has at least one active weed research project. In addition to the research being conducted by State and Federal agencies, many industrial firms have capable scientists who are conducting extensive weed research."

"Much of the weed research in the past has been done by men trained for other duties but who were transferred into weed work because of a shortage of adequately trained men. Future weed work will be done by men trained specifically for the job."

The chemical control of weeds in the grain belt of the middle west will go a long way toward reducing our noxious weed problems in the east, according to Dr. R. D. Sweet of Cornell University, who addressed the members of the Northeastern States Weed control conference this week at the Hotel New Yorker.

"Two,4-D and other chemical herbicides used in the production of wheat and corn will allow the shipment of food for eastern livestock and poultry that will contain many less weed seeds. These noxious weed seeds ordinarily live over in bird or animal bodies and are disseminated in the manure."

Recent weed control discoveries could not have been more timely in view of present world conditions is the comment of Dr. H. L. Yowell of Standard Oil Development Co., President of the Northeastern States Weed Control Conference now meeting at the Hotel New Yorker.

"At a time when farm labor, particularly that needed for the hand weeding of crops, is diminishing, newer chemical weed control methods can be used to maintain high production. Oil sprays have already eliminated the need for gangs of imported labor of high school children to weed carrots. Onions can be partially weeded with cyanate sprays while many weeds in corn can be killed by 2, 4-D."

MORE THAN 60 papers were presented before the Conference. Nearly 300 scientists from most of the Eastern states gathered for the three day meetings to give the results of their latest research on the control of weeds or to listen to the reports of their colleagues.

Paul J. Linder of the USDA reported on a series of experiments to study the methods of absorption of some of the newer organic herbicides by plants. His research indicated that sodium, 2,4-D ethyl sulfate, IPC, chloro IPC and phenyl mercuric acetate were relatively more toxic when applied to the soil around bean and oat seedlings than when applied to the stems or leaves. Maleic hydrazide and 3,6-endoxohydrophthalates, however, were as effective when applied to the stem as when applied to the roots.

A new theory for the mechanism of plant tolerance and susceptibility to oils was advanced by S. L. Dallyn and R. D. Sweet of Cornell University. The fact that carrots and related plants are not killed by Stoddard Solvent sprays while most weeds and other crops perish is explained on the basis of a difference in cytoplasmic membranes of the plant cells which prevents the entrance of oil into the cells of the tolerant plants.

The hazardous effects of 2,4-D vapor drift on nearby sensitive crops may be largely eliminated according to a paper by L. J. King and J. A. Kramer of Boyce Thompson Institute. They reported that the polyethylene glycol esters of 2, 4-D compare favorably in toxicity to regular, 2,4-D compounds but are much less volatile.

The hand labor required to raise a crop of strawberries was reduced by two-thirds where chemical weed control was used, according to R. F. Carlson and J. E. Moulton of Michigan State College. 2,4-D and a material called Experimental Herbicide No. 1 gave excellent weed control without injury to the berry plants or fruit.

A simultaneous control of weeds and insects in strawberries with a single chemical was reported by L. L. Danielson and R. N. Hof-

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New Farm Chemicals

(Continued from page 16)

63 per cent over the control plants by a 1 per cent application of UN and to 65 per cent over the controls by 0.1 per cent ClA sprays.

When in the calyx stage, the fruit set was reduced by 75 per cent with 0.1 per cent ClA sprays and 70 per cent by 0.32 per cent UN spray. At these low concentrations there was no evident injury to stems or foliage. Mature bean plants (Tendergreen variety) were sprayed with a 1 per cent solution of ClA and UN. Both acid and salt formulations of ClA and the acid of UN caused complete killing of leaves. The amine salt of UN did not kill bean leaves but injured weeds in the plots. This is further evidence of the selective action of UN as based on formulations and may have some application in connection with chemical weeding of gardens.

The team of scientists who performed and carefully documented the work reported here conclude from their experiments that monochloracetic acid and undecylenic acid are effective defoliants and weed-killers, the degree of effectiveness depending upon the species, the formulation, and the concentration. The two substances may be mixed together to increase their effectiveness as related to the number of species affected or to toxicity. In addition to their use as defoliants and selective weed killers, results of the tests indicate possible uses as blossom thinners, especially of apple.

Thus it appears that two more substances may soon join the growing family of farm chemicals if pesticide manufacturers decide to make the materials available commercially in forms ready for use by the consumer. ◆

Weed Conference
(Continued from page 34)

master of the Virginia Truck Experiment Station. Herbicidal concentrations of Sinox General not only killed chickweed and henbit but also gave excellent control of the two-spotted spider mite.

Cape Cod cranberries are now weeded chemically on a limited scale, according to C. E. Cross of the Massachusetts Cranberry Experiment Station. Stoddard Solvent, 2,4-D and copper sulfate are three more common materials being tried.

In reporting on weed control at Seabrook Farms, Bridgeton, N. J., T. P. Finn and L. J. King stated that Experimental Herbicide No. 1 effectively controlled weeds in asparagus and corn without affecting the yield or tastes of either crop.

Results of investigations by Joe Antognini of Cornell University indicate that oils and other chemicals can be used successfully for the control of weeds in onions if the spray is confined to the onion stem. This item spraying appears promising under conditions where level cultivation is practiced.

Lima beans can be weeded chemically by applications of weed-killers to the soil before the bean seedlings emerge according to a paper presented by W. C. Jacob of Cornell University. The same materials applied in a similar manner, however, to direct deeded cauliflower were not satisfactory.

Weeds in pea fields may be controlled by granular calcium cyanamide according to Peter Hahn of the American Cyanamide Co. The chief advantages of this material are the ease of application and the plant feeding benefits of the nitrogen in the material.

Chemical weeding of potatoes is not yet commercially practical according to J. H. Ellison and W. C. Jacob of Cornell University. Two years' results indicate that normally cultivated potatoes will outyield uncultivated chemically weeded fields. In all cases the treatments affording the best weed control also produced the largest yields. Normal cultivation was superior in this respect.

An evaluation of ten crabgrass killers by Gene Nutter and John Cornman of Cornell University indicated that phenyl mercuric acetate, potassium cyanate and dichloral urea performed the best.

Means of altering the effectiveness of potassium cyanate for crabgrass control was discussed by R. H. Beatty and B. H. Davis of the American Chemical Paint Co. They concluded that several applications of the herbicide were necessary for weed control and that there was an advantage of mixing 2,4-D with the cyanate. A fairly fine spray is necessary for best results.

The use of repellants offers a possible solution to the problem of toxicity of sodium arsenite when its use is contemplated as a herbicide or soil sterilant according to a paper by R. E. Frans and R. J. Aldrich of Rutgers University. Z.i.p. and z.a.c. sprayed on arsenite treated pastures caused cows to avoid the area.

The effectiveness of 2,4-D, sodium arsenite and trichloroacetic acid were increased by the addition of wetting agents according to E. R. Laning, Jr. and R. J. Aldrich of Rutgers University.

Weeds in turf can be controlled without the use of chemicals says F. V. Grau, Director of the U. S. Golf Association Green Sections. The cause of weedy turf should be determined and known factors such as inadequate fertilization, disease, soil compaction, or insect damage corrected. Specialized equipment may be the answer in controlling weeds. The effectiveness of chemical weed-killers is greater and at lower cost when cultural and mechanical principles first are invoked.

A less expensive means of controlling weeds in the 100,000 acres of dry beans raised in New York, was advanced by A. J. Tafuro and John Van Geluwe of the Coop. G. L. F., Inc. Water soluble dinitro materials (Premerge and Sinox PE) consistently gave best residual weed control and eliminated two cultivations.

The production of off-flavor milk by cows eating wild garlic plants may be reduced by chemical weed killers according to S. M. Raleigh of Penn State. Treated once each spring for three years with 2,4-D, wild garlic was effectively controlled.

A relatively weak sister of 2,4-D appears to be a safe weed-killer for use on legume seedlings according to A. J. Tafuro and John Van Geluwe of the Coop. G. L. F., Inc. 2,-methyl, 4-chlorophenoxy-acetic acid gave excellent control of wild mustard without hurting ladino clover or alfalfa.

Two relatively new chemicals were reported by P. W. Zimmerman, A. E. Hitchcock and H. Kirkpatrick of Boyce Thompson Institute as having defoliating properties. Undecylenic acid and monochloracetic acid removed rose, bean and fruit tree leaves and in addition were effective as weed-

(Continued on page 40)


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Ammonium Nitrate

(Continued from page 30)

ously explosive either by compression in a pile or by passage through a crystal transition.

Many other inaccurate statements and conclusions published in recent literature are equally unfounded.

Should a fire break out in an area where fertilizer-grade ammonium nitrate is stored, it is important that the mass be kept cool and that the burning be extinguished promptly. Large volumes of water should be applied as quickly as possible. This is the primary recommendation based on experience.

It is good practice to provide as much ventilation as possible to the area of the fire immediately after fire breaks out. Rapid dissipation of both the products of decomposition and the heat of reaction is very important.

Equally as important as fighting the fire effectively is an orderly clean-up operation. Damaged or unsalvageable material should be disposed of by burying or by dumping into a stream or pond of water. As soon as the fertilizer material has been removed from the damaged area, the latter should be thoroughly scrubbed and flushed with water, and all residual material washed away. ◆

Weed Conference

(Continued from page 38)

killers. For a full report on these two new farm chemicals, see page 00, this issue.

Increased milk production in the east through pasture improvement by use of chemical weed killers is the prediction of John Van Geluwe and C. V. Flagg of the Coop. G. L. F., Inc. Cut stumps of the hard-to-kill pasture weed, thorn apple, were prevented from resprouting by applications of 2,4-D and 2,4,5-T in oil.

The chemical treatments of brush along roadsides by highway departments can be more effective by the use of 2,4,5-T according to A. M. S. Pridham of Cornell University. Seedlings of ash up to an inch in diameter were killed by basal sprayings in winter of 2,4,5-T in oil.

Utility corporations should not always regard grass as the ideal ground cover according to F. E. Egler of Norfolk, Conn. Desirable shrublands have a remarkable ability to resist invasion of unwanted woody plants which may allow them to be maintained at a lower cost than grasslands.

Maleic hydrazide appears to be anything but a "quack" remedy when it comes to controlling quack grass according to W. E. Snyder of Cornell University. This material either reduced or inhibited growth depending on the concentration used and was more effective than trichloroacetate.

The challenge presented in controlling weeds detrimental to public health is one on which public health officials and agricultural officials must work together to protect the public health, welfare and comfort of the citizens of New Jersey, stated John Zemlansky, District Health Officer of the New Jersey State Department of Health. Only one-fourth of the population of the state is now protected by some degree of ragweed and poison ivy control programs.

"Operation Sneeze" was described by L. Slote and W. T. Ingram of New York University as a study of pollen pollution of air. They described the factors to be studied in order to devise and evaluate effective ragweed control programs. ◆

Industrial News

Delaney Committee Report—Expanded Facilities New Equipment—Promotions—Books—Research

Interim Report Clears Fertilizers

Delaney Committee to Investigate Further the Use of Other Chemicals in Growing and Processing of Food

IN AN INTERIM report on its studies of existing laws regulating the use of chemicals on and in foods, the Delaney Committee exonerated chemical fertilizers as a public health hazard.

"No reliable evidence was presented [during hearings held last year—ED.] that the use of chemical fertilizers has had a harmful or deleterious effect on the health of man or animal," said the report. The report noted that commercial fertilizers have been used for about 100 years, and that during the hearings some of the nation's most eminent soil and plant scientists testified that the use of chemical fertilizers does not injure the soil and is not responsible for any of man's illnesses.

With regard to pesticides, however, the committee recommended that its authority to investigate them as well as chemicals used directly in foods be extended in the new congress. The committee said that the "increasing use of chemical additives in the production and processing of foods has raised a serious problem as far as public health is concerned. The rapidity with which substances heretofore foreign to the body are being introduced in the production, processing, storage, packaging and distribution of food is alarming."

Chemicals used in foods were classified by the committee as follows:

1. Pesticides, including insecticides, fungicides, ascaricides, herbicides and plant growth regulators.
2. Chemicals used as preservatives, anti-oxidants, mild inhibitors and emulsifying agents added to food during processing or storage.
3. Chemicals used to wash utensils in food production, processing and wrapping.
4. Wax coatings, resins, plasticizers and other ingredients of food-packaging materials.

The report noted that during the hearings a witness for the Food and Drug Administration testified that over 800 chemicals are used, have been used, or have been suggested for use in foods. Of this total, it has been estimated that 704 are in use now, and of that number only 428 are definitely known to be safe as used.

Some of the pesticides found hazardous to public health were named specifically in the report. DDT, chlordane, selenium and phenyl mercury were some of these. The committee believes that further testimony should be taken to determine whether, and in what ways, existing laws may be inadequate with regard to insecticidal spray residue .

"There is nothing objectionable *per se* in the introduction of chemicals in the processing and preservation of foods," stated the report. "Indeed, their use has been of benefit to the consumer, as, for example, the addition of iodine to salt in areas where there is an iodine deficiency in the diet. However, as in the case of pesticides, chemicals have been used in food processing which have proven harmful or which were utilized before their harmlessness had been established."

A resolution to continue the investigation through July 1, 1951, was introduced.

International Starts Three New Facilities

Formal ground breaking ceremonies for International Minerals & Chemical Corporation's new plant food and superphosphate plant in North Fort Worth were held December 13, 1950.

The new plant, scheduled for completion about June 15, 1951, will have an annual production capacity of approximately 40,000 tons of plant food and will represent an investment in land, buildings and equipment of approximately $500,000.

The new International plant will incorporate the most modern methods of fertilizer manufacture, including the latest materials handling systems obtainable. An overhead conveyor system will carry superphosphate from the superphosphate plant into the main mixing building; and manufacturing, bagging and storing procedures are all planned for highest efficiency and a minimum amount of delay for customers.

A canopy over one of the loading docks will make it possible to load and cover plant food regardless of weather conditions. Special facilities for customers, including rest rooms, are planned.

The plant, office building and locker house are all laid out with future expansion in mind, Maurice H. Lockwood, vice-president in charge of the company's plant food division, said. The offices will be one story in height and will be consistent in design with other office buildings International has erected at its other plants.

The company has plants and offices in 50 cities and 20 states. In addition to manufacturing superphosphate and mixed fertilizers, it is the largest producer of phosphate, ranks third in the domestic production of potash, is one of the major firms in the chemical industry, and is the world's largest producer of monosodium glutamate, a master seasoning marketed under the trade name "Ac'cent." Its headquarters is in Chicago.

J. R. Murphy & Co. of Fort Worth is general contractor for the new plant. A. J. Sackett & Sons

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International

(*Continued from page 8*)

of Baltimore, Md., will supply plant equipment; equipment for the manufacture of superphosphate will be obtained from Sturtevant Mill Company, Boston, Mass.; steel work will be supplied by Mosher Steel Company, Dallas, Texas; and the conveyor system will be purchased from Barber-Greene of Aurora, Ill.

New Office Building

Functions of the departments it will house have dictated the design of the new brick and glass office building now being erected at Bartow, Florida, by International Minerals & Chemical Corporation, according to Franklin Farley, vice president of the corporation in charge of its Phosphate Division.

Florida phosphate headquarters of International will be moved from Mulberry to Bartow when the new offices are finished in order to be nearer the center of the corporation's Florida operations.

"Separate wings for administrative, engineering, accounting and personnel departments will coordinate departmental activities and result in a minimum amount of traffic in the hallways," Mr. Farley said. "This will be an improvement over the division's present office, which was constructed originally as a home 40 years ago. The present office is four times the size of the original building. However, production in our Florida Phosphate Division has grown 10 times since the old office was first occupied and we now have about 75 people in the Mulberry office."

The new building will be of completely fireproof concrete construction with reinforced steel. It has been designed all on one floor with windows affording best material lighting and will have such modern features as climate control, a special noise control area in the accounting department, acoustical treatment throughout, fluorescent lighting, and use of color engineering principles in decorating.

A cold water air conditioning system aided by heating and ventilating facilities will provide individual control of the "climate" at various points through the building. Heat-absorbing plate glass will restrict transmission of heat and help keep the offices comfortable on the hottest days.

Since many people visit the personnel department, a meeting room that will seat 150 will be part of the personnel wing. The personnel department will also contain separate interview rooms. An employee lounge will be connected to a covered terrace.

The building will have a total floor area of 20,000 square feet and will be built on a 30-acre tract just south of Bartow's city limits. It is expected to be completed in August, 1951, and will cost approximately $350,000 including furnishings.

Robert Law Weed & Associates of Miami, designers of the University of Miami, are the architects. The contractor is Paul Smith of Tampa, Florida.

Mr. Farley also announced that construction of a half-million-dollar service center and warehouse is proceeding in the Noralyn plant area near Bartow and that completion is scheduled for about May 1, 1951. It will be the most modern maintenance center of its type in the southeast, he said, and will provide a light mechanical shop, a heavy mechanical shop, an electric shop, an automotive shop, and a warehouse.

The structure will have a floor area of 42,700 square feet and will accommodate 150 workers. All functions will be integrated and coordinated through general offices located so everyone can easily get into his own area. "The structure was designed from the inside out," Mr. Farley said. "We knew what we wanted it to do, and it was designed around those functions."

Research Laboratory

International Minerals & Chemical Corporation plans to build a new central research laboratory of modern, fireproof construction, having an area of about 33,000 square feet, at Shokie, Ill.

Plans announced the 20th of last month said that negotiations were under way for the purchase of a 15-acre tract in Skokie that is located near Highway 58 and bounded on one side by the Chicago, North Shore and Milwaukee Railroad. Part of the land is now classed as residential, but an application is pending before the local zoning board to have the property reclassified. If the application is approved by the board, construction of the plant will begin as soon as possible thereafter.

The laboratory will be staffed by around 75 specialists, many of them nationally recognized in their field, and will be under the direction of Dr. Paul D. V. Manning, vice-president in charge of the company's research division.

Research at the new center will be in connection with the various operations of the International Minerals & Chemical Corporation. These include mining and refining of potash and phosphate, the manufacture of plant foods and elements for animal feed, amino products, and pharmaceuticals.

W. L. Jenkins

Jenkins Appointed Barrett N. C. Representative

The Barrett Division, Allied Chemical & Dye Corporation, has announced the appointment of W. L. Jenkins of Shelby as sales representative in 37 western North Carolina counties for "Arcadian" nitrate of soda, "A-N-L" Brand Fertilizer Compound and other nitrogen materials distributed by Barrett for direct application.

Mr. Jenkins, a native of Cleveland County, is a graduate of Polkville High School and Gardner-Webb College. He served four years with the Army Air Corps during World War II, eighteen months of which were spent overseas.

(*More news on page 46*)

Industrial News *(Continued)*

Davison Promotes Roop and Hardesty

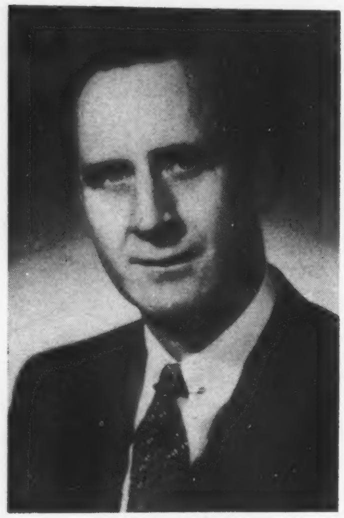
Marshall C. Roop, who has a 25-year record of service with The Davison Chemical Corporation and its predecessor company, was elected Vice President-Finance of Davison at a recent meeting of the Board of Directors. The position is a new one created by the Board.

Prior to his election as a vice president, Mr. Roop was both Secretary and Treasurer of the chemical concern. He will retain the former office.

The new Treasurer, also elected by the Davison Board of Directors, is J. Early Hardesty, former Assistant Secretary and Assistant Treasurer. Mr. Hardesty, a member of the American Institute of Accountants and the Maryland Association of Certified Public Accountants, joined Davison as an accountant in 1934.

Mr. Roop, a member of both the Controller's Institute of America and the Maryland Association of Certified Public Accountants, first came to Davison in 1919 after serving in World War I as an Ensign in the Navy, and remained until 1921. He practiced public accounting from 1921 to 1928, when he rejoined The Davison Chemical Company, and served in various executive capacities in the accounting and finance departments. He also served in an executive capacity under the receiver, Chester F. Hockley, and was elected Controller and Secretary of the reorganized firm, The Davison Chemical Corporation in 1935, his election as Secretary and Treasurer coming in 1946.

M. C. Roop



J. E. Hardesty

Mr. Hardesty, who has been Assistant Secretary and Assistant Treasurer since 1946, will retain the office of Assistant Secretary. He will be succeeded as Assistant Treasurer by J. Sinclair Marks, who has been with the company since 1929.

New Edition of A. O. A. C. Official Methods of Analysis

The seventh edition of "Official Methods of Analysis" has been published by the Association of Official Agricultural Chemists. This volume includes all changes in official analysis methods adopted up to and including the annual meeting of October, 1949.

The chapters of the book have been arranged in a more logical sequence, being divided into six general groups in keeping with the materials with which they individually deal: 1. Soils and materials related thereto. 2. Miscellaneous materials not foods or drugs. 3. Foods. 4. Drugs and cosmetics. 5. General methods. 6. Reference tables.

The volume contains 910 pages, with 73 illustrations and 31 reference tables. The price is $10 per copy, postpaid, for purchasers in this country; $10.50 for foreign orders. Orders should be sent to the Association of Official Agricultural Chemists, P. O. Box 540, Benjamin Franklin Station, Washington 4, D. C.

USDA Engineer Reports on Fertilizer Equipment

The increasing use of various forms of fertilizers in this country has caused fertilizer equipment to become the most diversified of any type of farm machinery now on the market, says Glenn A. Cumings, agricultural engineer of the U. S. Department of Agriculture. Speaking before the winter meeting of the American Society of Agricultural Engineers in Chicago on December 20, Cumings outlined progress in the development of fertilizer machinery and cited industry's opportunity for greater improvement in years to come.

Today's fertilizer equipment ranges from small, hand-operated devices through tractor units and self-unloading trucks to aircraft with spreading attachments. This equipment is used to apply fertilizers as gases, liquids, crystals, granules and finely divided particles. Furthermore, Cumings pointed out, present day fertilizer machinery is often incorporated with an implement designed to do several other farm jobs.

Cumings outlined one new trend in which fertilizer equipment is being designed as the basic unit and interchangeable planters, drills, seeders and cultivators are used as attachments.

An example of the versatility of modern fertilization machinery described by the Department engineer is the commercially produced two-hopper fertilizer unit that mounts on the front of a rear-engine tractor. The fertilizer from each hopper can be delivered through either one or two tubes. Fertilizer can be applied as side dressing for crops, in conjunction with plowing, planting, and drilling vegetable seed. The unit will, of course, operate alone, applying fertilizer on the soil surface as top dressing.

It's reported that USDA is considering asking the National Production Authority to allocate fertilizers and insecticides to cotton producers, but it's reluctant to start playing with these controls, especially when it is doubtful if even this will get enough cotton. ◆

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Davison Chemical Corporation, Baltimore, Md.
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MACHINERY—Ammoniating
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MACHINERY—Grinding and Pulverizing
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BUYERS' GUIDE

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Baughman Manufacturing Co., Jerseyville, Ill.
Hayward Company, The, New York City
Hough Co., The Frank G., Libertyville, Ill.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.

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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Power Transmission
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Superphosphate Manufacturing
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE
McIver & Son, Alex. M., Charleston, S. C.

MINOR ELEMENTS
Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agrictultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Barrett Div., Allied Chemical & Dye Corp., New York City
International Minerals & Chemicals Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.

NITROGEN SOLUTIONS
Barrett Div., Allied Chemical & Dye Corp., New York City
Lion Oil Company, El Dorado, Ark.
Phillips Chemical Co., Bartlesville, Okla.
Spencer Chemical Co., Kansas City, Mo.

NITROGENOUS ORGANIC MATERIAL
American Agriculture Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Virginia-Carolina Chemical Corp., Richmond, Va.

PLANT CONSTRUCTION—Fertilizer and Acid
Atlanta Utility Works, The, East Point, Ga.
Chemical Construction Corp., New York City
Monsanto Chemical Co., St. Louis, Mo.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.
Titlestad Corporation, Nicolay, New York City

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.

POTASH SALTS—Manufacturers
American Potash and Chemical Corp., New York City
Potash Co. of America, New York City
International Minerals & Chemical Corporation, Chicago, Ill.
United States Potash Co., New York City

PRINTING PRESSES—Bag
Schmutz Mfg. Co., Louisville, Ky.

REPAIR PARTS AND CASTINGS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.

SCALES—Including Automatic Bagging
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.

SCREENS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Mach. Works, Aurora, Ind.

SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

STORAGE BUILDINGS
Marietta Concrete Corporation, Marietta, Ohio

SULPHATE OF AMMONIA
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Barrett Div., Allied Chemical & Dye Corp., New York City
Jackle, Frank R., New York City
Koppers Co., Inc., Tar Products Div., Pittsburgh, Pa.
Lion Oil Co., El Dorado, Ark.
McIver & Son, Alex. M., Charleston, S. C.
Phillips Chemical Co., Bartlesville, Okla.
United States Steel Corp., New York City
Woodward & Dickerson, Inc., Philadelphia, Pa.

SULPHUR
Ashcraft-Wilkinson Co., Atlanta, Ga.
Texas Gulf Sulphur Co., New York City

SULPHURIC ACID
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Planters Fertilizer & Phosphate Co., Charleston, S. C.
Southern States Phosphate Fertilizer Co., Savannah, Ga.
U.S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Virginia-Carolina Chemical Corp., Richmond, Va.

SUPERPHOSPHATE
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Davison Chemical Corporation, Baltimore, Md.
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Planters Fertilizer & Phosphate Co., Charleston, S. C.
Southern States Phosphate Fertilizer Co., Savannah, Ga.
U.S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Virginia-Carolina Chemical Corp., Richmond, Va.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Minerals & Chemical Corporation, Chicago, Ill.
U.S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Virginia-Carolina Chemical Corp., Richmond, Va.

TANKAGE
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

VALVES
Atlanta Utility Works, The, East Point, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

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